JUN 30 1925

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See Advertisement, page 33. 2257

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High-class GUNMETAL STEAM FITTINGS.
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See Advertisement, page 43. 2584

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See Advertisement page 60, June 12. 2402

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Civil Service Commission.

—FORTHCOMING EXAMINATION. Probationary ASSISTANT ENGINEER in the Engineering Department of the General Post Office (20-23, with extension in certain cases). Regulations and particulars are obtainable from The SECRETARY, Civil Service Commission, Burlington Gardens, London, W.1, together with the form on which application must be made.—The latest date for the receipt of application forms is 30th July. J 359

Correspondence Courses for

Inst. Civil Engrs., Inst. Mech., London Univ. (Matric., Inter., B.Sc.), Inst. M. & Cy.E., and ALL ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours) Eng. London, Assoc.M.Inst.C.E., Chartered Civil Engineer. M.R.S.I., F.R.S.A., etc. Also Day Tuition in Office. Excellent results at all Exams., comprising hundreds of successful Students. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to 8/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN STREET, LIVERPOOL. 2689

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Negotiating with Government Departments in connection with any post, please communicate with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's Square, London, S.W.1. G 758

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and SALES MANAGEMENT.—Write for brochure describing our special Course of Training for posts of unlimited scope in the lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 77, Milligate Building, Manchester. 2863

TENDERS.

THE DIRECTOR-GENERAL, INDIA STORE DEPARTMENT, Branch No. 16, Belvedere Road, Lambeth, S.E.1, invites

Tenders for :—

1. STEEL SCREW SPIKES.
2. PETROL TANK RAILWAY WAGONS.
3. TWO DRAGLINE EXCAVATORS 85 ft. boom, buckets 2¼ yards capacity.
4. WHEELS AND AXLES for Railway Carriages.
5. UNDERFRAMES, BOGIE TRUCKS, IRONWORK, etc., for Railway Carriages.

Tenders due on the 25th June, 1925, for No. 1, on the 7th July, 1925, for No. 2, on the 9th July, 1925, for No. 3, and on the 14th July, 1925, for Nos. 4 and 5.

Tender forms obtainable from above. J 349

HAWARDEN RURAL DISTRICT COUNCIL.

ELECTRICITY SCHEME.

Tenders are Invited for :—

(1) SUB-STATION TRANSFORMERS.
(2) Do. SWITCHGEAR.

Copies of Specifications, General Conditions, and Forms of Tender can be obtained from the undersigned upon payment of a deposit of £1 1s. for each Section returnable after receipt of a *bona-fide* Tender. Tenders must be received by me not later than Twelve Noon, on Thursday the 26th June, 1925.

ARNOLD K. WRIGHT,
Clerk to the Council.

Council Offices, Broughton, Nr. Chester.
June 11th, 1925. J 318

GLOUCESTERSHIRE COUNTY COUNCIL.
LONDON—SOUTH WALES TRUNK ROAD A.40 IN GLOUCESTERSHIRE.
CONTRACTS.

THE HIGHWAYS AND GENERAL PURPOSES COMMITTEE OF THE GLOUCESTERSHIRE COUNTY COUNCIL invites

Tenders from Contractors for

the following WORKS on the above-named Road :—

CONTRACT No. 6. The RECONSTRUCTION of the MAIN ROAD A.40 between GLOUCESTER and CHELTENHAM—approximate distance four and a half miles—in two coat asphalte work, with subsequent maintenance, also strengthening of haunches and subsidiary works.

Tenders for this Contract will only be considered from Firms of established reputation in asphalte construction and subsequent maintenance.

CONTRACT No. 7. The RECONSTRUCTION of the MAIN ROAD A.40 in the CHARLTON KINGS URBAN AREA between COPT ELM ROAD and HEARNE ROAD—approximate distance 620 yards—in Tarred asphaltic Macadam in two coats, with subsequent maintenance, with surface drainage, kerbing and other subsidiary works.

CONTRACT No. 8. The RECONSTRUCTION of the MAIN ROAD A.40 in the CHARLTON KINGS URBAN AREA from HEARNE ROAD to the BOUNDARY OF THE URBAN AREA AT DOWDESWELL—approximate distance 2140 yards—in two coats asphalte, with subsequent maintenance, also strengthening of haunches and other subsidiary works.

Tenders for this Contract will only be considered from Firms of established reputation in asphalte construction and subsequent maintenance.

Plans and detail drawings can be seen at the Office of the Resident Engineer, 10, Promenade, Cheltenham, and the General Conditions, Specification and Bills of Quantities can be obtained thereat on and after the 15th June, 1925, on payment of the sum of £5 5 0, which will be returned on the receipt of a *bona fide* Tender.

Tenders to be sent to the County Surveyor not later than the 1st July, 1925.

The COMMITTEE does not bind itself to accept the lowest or any other Tender.

COUNTY SURVEYOR,
Shire Hall, Gloucester.
6th June, 1925. J 349

TO CONTRACTORS.

THE COMMISSIONERS OF HIS MAJESTY'S WORKS, etc., are prepared to receive separate

Tenders before Eleven

a.m., on Friday, 3rd July, 1925, for the SUPPLY of (a) MECHANICAL and (b) ELECTRICAL ENGINEERING LABOUR in the Manchester District during a period of Three years from the 1st August, 1925.

Forms for Tender, etc., may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles Street, London, S.W.1. J 339

STROOD RURAL DISTRICT COUNCIL.

BITUMEN AND TAR SPRAY BOILER.

The above Council invite

Tenders for the Supply and

DELIVERY of ONE 160 gallons capacity BITUMEN and TAR SPRAY BOILER.

Copy of Specification may be had (on application) of Mr. L. RANDERSON, Surveyor, Surveyor's Offices, Meopham, Gravesend.

Tenders endorsed "Bitumen and Tar Spray Boiler," must be received by the undersigned on or before the 16th July, 1925.

The lowest Tender will not necessarily be accepted.

J. E. POVEY,
Clerk to the Council.

Union Offices,
STROOD,
Rochester.
12th June, 1925. J 342

COUNTY BOROUGH OF BRIGHTON.

WATERWORKS DEPARTMENT.

TO PIPE FOUNDERS.

The Waterworks Committee invite

Tenders for the Supply of

about 360 tons of 16in. diameter Class "C," 240 tons of 18in. diameter Class "B," and about 320 tons of 18in. diameter Class "C" CAST IRON PIPES to the British Standard Specification, together with Specials of both diameters, delivered in Brighton.

Specification and Form of Tender may be obtained from the Waterworks Engineer, Mr. A. B. CATHCART, M.Inst.C.E., 12, Bond Street, Brighton, upon payment of a deposit of Two Guineas, which will be refunded upon receipt of a *bona fide* Tender not subsequently withdrawn.

Sealed Tenders, endorsed "Tender for C.I. Pipes," to be delivered at my Office, Town Hall, Brighton, not later than Noon, on Monday, July 6th, 1925.

The Committee do not bind themselves to accept the lowest or any Tender.

JAS. H. ROTHWELL,
Town Clerk.

Town Hall,
Brighton,
10th June, 1925. J 307

CITY OF LEICESTER.

STORM WATER AND SEWAGE DISPOSAL WORKS.

CONTRACT No. 3.

BACTERIAL WORKS, BEAUMONT LEYS FARM.

The Leicester Corporation are prepared to receive

Tenders for the Construction

of New Sedimentation Tanks, Percolating Filters, Channels, Humus Tanks, Drains and Pipe Lines, Roads, and the erection of new Pumping Stations, Recorder House, etc., and all other Works in connection therewith, according to the drawings prepared by the City Surveyor.

Plans may be seen and copies of the Conditions of Contract, Specification, Bill of Quantities, with Form of Tender, etc., obtained at my Office on and after 15th June, 1925, on payment of the sum of £5, which will be returned on receipt of a *bona-fide* Tender.

Cheques, etc., to be crossed and made payable to the Leicester Corporation.

Fully priced Quantities, together with the Summary of Tender and Tender on the Forms supplied, filled up and addressed to "The Chairman of the Sewage Works and Farms Committee, Town Hall, Leicester," are to be delivered complete not later than Nine a.m. on 11th July, 1925, endorsed "Tender for Bacterial Works."

The Corporation do not bind themselves to accept the lowest or any Tender.

E. GEORGE MAWBEY, M.Inst.C.E.,
City Engineer and Surveyor.

Town Hall, Leicester,
June, 1925. J 292

PORT OF BRISTOL.

RECONSTRUCTION OF SHEDS "E" AND "F," BRISTOL.

The Docks Committee invite

Tenders for the Reconstruction

of the TRANSIT SHEDS known as Sheds "E" and "F," situate on the Grove, Bristol.

The new shed will have a double floor with a ground area of 3300 square yards. The superstructure will contain 400 tons of steel and ironwork. The first floor will be boarded on timber joists and the roof will be slated on boarding and timber purlins. The foundations will be in concrete.

On and after Monday, the 22nd June, 1925, a copy of the Form of Tender, General Conditions, Specification, Schedule of Prices and a copy of the Contract Drawings can be obtained from the undersigned on production of a receipt showing that a deposit of £5 has been paid to the General Manager and Secretary of the Bristol Docks Committee, 19, Queen Square, Bristol. ALL CHEQUES MUST BE MADE PAYABLE TO THE BRISTOL DOCKS COMMITTEE. The deposit of £5 will be returned hereafter to all *bona fide* tenderers.

Tenders must be enclosed in a sealed envelope endorsed "Tender for the Reconstruction of Sheds 'E' and 'F,' Bristol," addressed to the General Manager and Secretary of the Docks Committee, 19, Queen Square, Bristol, and must be delivered to him accompanied by the prescribed documents and drawings before Ten a.m. on Monday, the 20th July, 1925.

The Docks Committee do not bind themselves to accept the lowest or any Tender.

THOMAS A. PEACE,
Chief Engineer,
Port of Bristol.

Chief Engineer's Office,
Avonmouth Docks.
19th June, 1925. J 345

The Owners of British Letters

Patent No. 140963, for "Apparatus for Discharging Material into Furnaces, Bunkers, or Trucks," are PREPARED to RECEIVE TENDERS for the MANUFACTURE of the APPARATUS in Great Britain or to consider applications for the grant of licences thereunder.

Applications in the first instance should be addressed to KILBURN & STRODE, 31, High Holborn, London, W.C.1. J 332

BOMBAY, BARODA AND CENTRAL INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to 2.30 p.m. on Wednesday, 1st July,

Tenders for the Supply of :—

COPPER FIREBOX PLATES.

Tenders must be made on forms, copies of which, with Specification, can be obtained at these Offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: 91, Petty, France,
Westminster, S.W.1.
17th June, 1925. J 358

CITY AND COUNTY OF NORWICH.
THORPE POWER STATION.

The Norwich Corporation invite

Tenders for the Manufacture,

DELIVERY and ERECTION of the undermentioned ENGINEERING WORKS in connection with the above Power Station, viz. :—

STEAM, WATER and other PIPEWORK, VALVES, TANKS, etc., etc.

Specifications, Drawings and Forms of Tender may be obtained from Messrs. PREECE, CARDEW AND RIDER, 8, Queen Anne's Gate, Westminster, S.W.1, on payment of a deposit of £5, which will be refunded on receipt of a *bona fide* Tender within the prescribed time.

Two Copies of the Specification and Form of Tender will be supplied to each applicant. Extra copies may be obtained on payment of Ten Shillings for each copy, which will not be returnable.

Sealed Tenders, endorsed "Thorpe Power Station, Tender for Pipework, etc.," must be delivered to me at my office not later than Ten a.m. on Friday, 3rd July, 1925.

The lowest or any Tender will not necessarily be accepted and the Corporation will not consider any Tender which is incomplete, or which does not include the whole of the work covered by the Specification.

ARNOLD H. MILLER,
Town Clerk.

Guildhall, Norwich.
8th June, 1925. J 268

COUNTY BOROUGH OF BRIGHTON.
WATERWORKS DEPARTMENT.

TO MAINLAYING CONTRACTORS.

The Waterworks Committee are prepared to receive

Tenders from responsible

Contractors for LAYING about 2520 yards of 18in., and about 1780 yards of 16in. CAST IRON MAINS in Ditchling Road, Hollingbury Road, Hollingdean Road, Old Lane, and Surrenden Road, Brighton.

Specification, Quantities, and Form of Tender may be obtained, and Drawings inspected, on application to Mr. A. B. CATHCART, M.Inst.C.E., Waterworks Engineer, 12, Bond Street, Brighton, on payment of a deposit of Three Guineas, which will be refunded upon receipt of a *bona fide* Tender, not subsequently withdrawn, and the return of all documents.

Sealed Tenders, endorsed "Tender for laying 18in. and 16in. Water Mains," to be delivered at my Office, Town Hall, Brighton, not later than Noon, on Monday, July 6th, 1925.

The lowest or any Tender will not necessarily be accepted, and Tenders will only be considered from responsible Contractors having the necessary experience.

JAS. H. ROTHWELL,
Town Clerk.

Town Hall,
Brighton.
10th June, 1925. J 308

By Order of the Receiver for Debenture Holders,
C. J. Pain, Esq., F.C.A.
MESSRS. CUTTING BROS.,
PARK WORKS,
STAMFORD.

HENRY BUTCHER & CO.
Have received instructions to offer

For Sale by Tender, as Going

CONCERN,
the Old-established
ELECTRICAL ENGINEERING WORKS
MANUFACTURING ELECTRIC MOTORS, GENERATORS, &c.

The Works are in full operation, with orders in hand and with Works and Office Staff which could be retained.

THE PROPERTY is FREEHOLD, having a site area of 4 acres, and comprising Workshops and Foundry with clear FLOOR SPACE of about 34,500 sq. ft. Offices, Yard and Land for extension adjoining the London, Midland & Scottish Railway.

The WORKSHOPS, IRON and BRASS FOUNDRIES are fully equipped with Modern Plant and Machinery.

Included in the assets are
COMPLETE WORKING DRAWINGS and PATTERNS
for Motors and Generators up to 100 Kw., Polishing Lathes, etc.
STOCK, STORES, FURNITURE and all EQUIPMENT.
Together with the
GOODWILL of the BUSINESS.

The Works may be inspected between the hours of Ten a.m. and Four p.m. from MONDAY, JUNE 29th, to FRIDAY, JULY 3rd, inclusive.

Tender Forms and full particulars can be obtained from :—

Messrs. HUBBART, DUROSE & PAIN, Chartered Accountants, 18, Low Pavement, Nottingham and 46, Holborn Viaduct, London, E.C.1,

Messrs. HENRY BUTCHER & CO., Engineering Auctioneers, Valuers and Surveyors, 63 and 64, Chancery Lane, London, W.C.2. J 345

THE SOUTH INDIAN RAILWAY COMPANY LIMITED.

The Directors are prepared to receive

Tenders for the Supply of :—

LOCOMOTIVE BOILERS.

Specifications and Forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W.1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Locomotive Boilers," must be left with the undersigned not later than Twelve Noon, on Friday, the 10th July, 1925.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of the Specification.

Copies of the Drawings may be obtained at the Offices of the Company's Consulting Engineers, Messrs. ROBERT WHITE & PARTNERS, 3, Victoria Street, Westminster, S.W.1.

A. MUIRHEAD,
Managing Director.

91, Petty France, Westminster, S.W.1.
17th June, 1925. J 368

APPOINTMENTS OPEN.

SWINDON AND NORTH WILTS TECHNICAL INSTITUTION.

Applications are Invited for

the POST of HEAD OF THE ENGINEERING DEPARTMENT from graduates with both Teaching and Works experience.

Salary in accordance with Burnham Agreements, as approved by the Board of Education, including an addition of £50 for Special Responsibility.

Further particulars and forms of application may be obtained from the PRINCIPAL, TECHNICAL INSTITUTION, SWINDON, not later than Wednesday, 24th June, 1925.

W. SEATON,
Secretary. J 286

MUNICIPAL TECHNICAL COLLEGE, SWANSEA.

Principal—T. GILBERT JONES, M.Sc., Wh.Sch., A.M.I.E.E., A.M.I.C.E.

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T. J. REES,
Director of Education.

Education Office,
Dynevor Place, SWANSEA.
9th June, 1925. J 289

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N. L. FLEMING,
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FRED. J. DIXON, M.Inst.C.E.,
Engineer-in-Chief.
Engineer's Office,
26a, Paradise Street,
Birmingham. J 348

Senior Waterworks Engineer

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THE DISTRIBUTION OF LOAD ON THE BALLS AND ROLLERS OF BALL AND ROLLER BEARINGS.

By Professor JOHN GOODMAN, M.Inst.C.E.

IN radially loaded ball and roller bearings, it is obvious that the balls or rollers close to the line of loading and on the opposite side of the bearing to the applied force are subjected to a greater load than are the balls or rollers at the sides of the bearing where there is no radial pressure. The proportion of the load supported by each ball or roller, and especially the one most highly loaded, is a matter of importance when determining the safe load for such bearings.

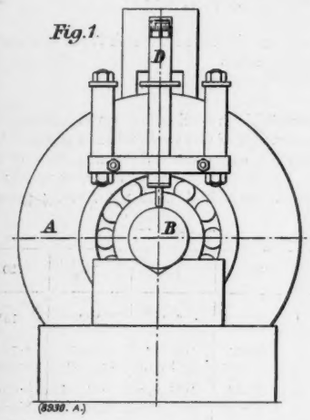
The commonly-accepted theory of the distribution of the load is due to Stribeck, who, in the absence of precise experimental data, made the following assumptions:—(i) That the elastic distortion of the balls and surfaces in a bearing follows the Hertz law for balls when compressed between two flat plates. (ii) That the pressure on the most highly-loaded ball in a slack fitting bearing is greater than in a perfect bearing having no shake, the exact ratio between the two being an unknown quantity.

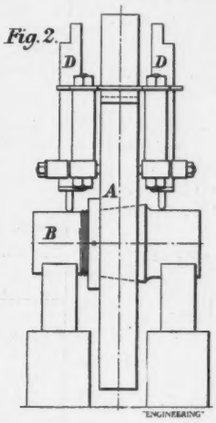
In a radial ball bearing the balls are not compressed between flat plates, but between convex and concave surfaces, both of which have grooves whose radius of curvature in modern bearings is from 2½ to 5 per cent. greater than the radius of the ball. A theoretical treatment of the approach of two such surfaces when loaded and separated by a ball has never been attempted as far as the writer is aware. Stribeck's arbitrary allowance for the effect of shake in ball bearings may, or may not, be justifiable; hence it seemed desirable that the actual distribution of the load on the balls of a bearing should be determined experimentally.

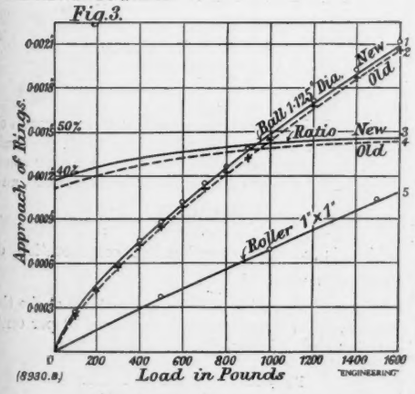
Two standard Hoffmann bearings (M 20) were used for the tests, one of which was new and, although free, had no appreciable shake, while the other had been in use for some time and had a certain amount of shake, but the balls and races were perfect as regards their surfaces.

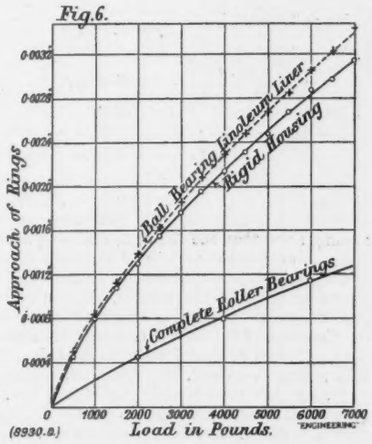
Method of Testing.—The bearing, shown in Figs. 1 and 2, under test was housed in a massive cast-iron ring A, having a small amount of clearance between the bore of the housing and the outer ring of the bearing. The space between was filled in with melted resin, which, when set, rigidly held the bearing ring without bringing any undue pressure upon it. The inside ring or sleeve of the bearing was tapered in the bore and was accurately fitted and ground to a shaft B, where it was held in position by a lock-nut. The shaft was supported at both ends in vee blocks.

By means of two Geneva precision gauges DD, which were clamped to the outer ring of the bearing, the clamps bearing on two points only, the approach of the outer and inner rings could be measured to the nearest $_{10,000}$th of an inch, or nearer when a lens was used. It will be obvious that no error crept in if a bodily movement of the whole apparatus took place, since the gauges only measured the distance between points on the outer ring and the shaft which was virtually solid with the inside ring.









The bearing was loaded by equal increments in a testing machine, and the corresponding approach of the rings was read off on the Geneva gauges, the mean of the two being taken.

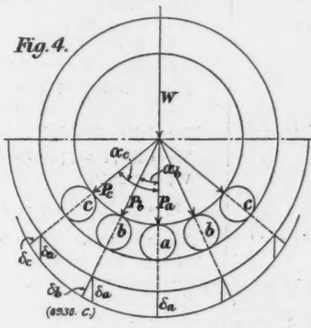
In the first place, the bearing contained its full complement of balls, and after being tested for ring approach two symmetrically placed balls nearest the horizontal diameter and on the same side as the applied load were removed and the test repeated. Later on more balls were removed, and so on until only the ball immediately in the line of loading remained. The approach of the rings under this condition supplied the data for enabling the approach of the rings to be calculated for a larger number of balls. Such calculations with curves are given below. Similar tests were afterwards made on a Hoffmann short roller bearing.

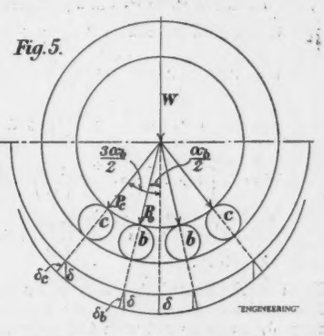
Results of Tests on Ball Bearings.—The following particulars are given of the ball bearings tested:—

Number of balls	... ...	12
Diameter of balls	... ...	1·125 in.
Radius of ball track	... ...	0·576 in.
Radius of ball / Radius of track	=	0·976
Outside diameter of bearing	...	8·1 in.
Diameter measured to the ball centres	... ...	6·0 in.
Diameter of shaft at small end of taper	... ...	3·59 in.
Radial shake in old bearing, mean of 24 readings	... ...	0·0062 in.
Radial shake in new bearing	...	Not appreciable.

The track radius is assumed to be the same in both, although in the old bearing the bottom of the track was slightly worn where the balls had been in contact with it; consequently the "fit" between the ball and race was doubtless closer than in the new bearing, but no means of measuring it appeared to be possible.

Approach of Two Grooved Rings when Separated by a Ball.—The manner in which the radial approach of the rings depends upon the load when they are separated by a single ball is shown in Fig. 3, curves 1 and 2. The new ring gave slightly higher approach values than the old, probably because the balls in the latter had worn a track in the old races and were therefore in closer contact than in the new races. Curves 3 and 4 show the ratio between the approach of the rings and the approach





of flat plates when separated by one ball. Curve 5 shows the approach of the outer and inner rings of a short roller-bearing. This roller was loaded up to 6,000 lb. by intervals of 500 lb.; only three points of observation come on this diagram.

Let δ be the approach of the rings in inches when separated by one ball.

P be the load on the ball in pounds weight.

Then the following expressions closely fit the experimental values:—

$$\text{Old bearing } \delta_o = \frac{P^{0\cdot757}}{129{,}100} \text{ or } \frac{P^{\frac{1}{1\cdot321}}}{129{,}100}$$

$$\text{New bearing } \delta_n = \frac{P^{0\cdot736}}{109{,}000} \text{ or } \frac{P^{\frac{1}{1\cdot359}}}{109{,}000}$$

Hertz's expression for a ball of the same size when loaded between flat plates is $\delta_f = \frac{P^{0\cdot667}}{33{,}290}$.

The author's experiments (ENGINEERING, August 24, 1923) on balls loaded between flat plates gave

$$\delta_f = \frac{P^{0\cdot673}}{33{,}290}$$

$$\text{Then } \frac{\delta_o}{\delta_f} = \frac{P^{0\cdot084}}{3\cdot88}$$

$$\frac{\delta_n}{\delta_f} = \frac{P^{0\cdot063}}{3\cdot27}.$$

The relations are shown by curves 3 and 4 in Fig. 3, from which it is evident that the ratio is not constant but depends upon the load. At normal working loads it is about 0·47.

Dr. Heerwagen (ENGINEERING, December 26, 1902) has arrived at this ratio by mathematical analysis for somewhat similar conditions, but, unfortunately, he does not give it for values beyond 0·928, whereas in these tests the ratio is 0·976, and, moreover, he does not give sufficient data to enable other values to be calculated. If, however, Heerwagen's table be plotted and a curve be drawn through his points, the value given above falls on his extrapolated curve as near as can be judged, thus showing that the experimental value appears to agree with the theoretical.

Calculation of the Distribution of Load on the Balls in a Bearing.—When a ball bearing is under load let the pressure on the ball *a*, Fig. 4,

immediately in the line of loading, be p_a, and the approach of the two races be δ_a.

The radial approach at b is $\delta_b = \delta_a \cos a_b$.

If m be the number of balls in the bearing

$$a_b = \frac{360}{m} \text{ and } a_c = 2\left(\frac{360}{m}\right)$$

$\delta = \frac{P^n}{K}$ where P is the normal pressure on the ball and K is a constant for any given size of ball. Then

$$\frac{P_a^n}{\delta_a} = \frac{P_b^n}{\delta_b} = \frac{P_c^n}{\delta_c} \text{ and so on.}$$

$$P_b = \frac{P_a \, \delta_b^{\frac{1}{n}}}{\delta_a^{\frac{1}{n}}}$$

substituting the value of δ_b and a_b

$$P_b = P_a \cos^{\frac{1}{n}}\left(\frac{360}{m}\right) \text{ and } P_c = P_a \cos^{\frac{1}{n}} 2\left(\frac{360}{m}\right)$$

The vertical component of the pressure P_b is $P_b \cos a_b$, and of P_c is $P_c \cos a_c$. Then—

$$W = P_a + 2\,(P_b \cos a_b + P_c \cos a_c + \&c.)$$

$$W = P_a + 2\left(P_a \cos^{1+\frac{1}{n}}\left(\frac{360}{m}\right) + P_a \cos^{1+\frac{1}{n}} 2\left(\frac{360}{m}\right) + \&c.\right)$$

$$W = P_a\left[1 + 2\left\{\cos^{1+\frac{1}{n}}\left(\frac{360}{m}\right) + \cos^{1+\frac{1}{n}} 2\left(\frac{360}{m}\right) + \&c.\right)\right. \quad \text{(i)}$$

$$W = K_1 P_a,$$

From which the load P_a on the ball a can be calculated. Then the corresponding approach of the rings δ_a as compared with the approach δ_1 when there is only one ball under the same load W is :—

$$\frac{\delta_a}{\delta_1} = \left(\frac{P_a}{P_1}\right)^n = \left(\frac{W}{K_1 P_1}\right)^n$$

and since $W = P_1$

$$\delta_a = \left(\frac{1}{K_1}\right)^n \delta_1$$

When the line of loading passes between the two most heavily loaded balls (see Fig. 5), *i.e.*, when the number of balls is even, we have—

$$\delta_b = \delta \cos \frac{a_b}{2} = \delta \cos M \text{ where } M = \frac{360}{2m}$$

$$\delta_c = \delta \cos \frac{3\,a_b}{2} = \delta \cos 3\,M$$

$$\delta_c = \delta_b \frac{\cos 3\,M}{\cos M}$$

$$P_c = P_b \frac{\delta_c^{\frac{1}{n}}}{\delta_b^{\frac{1}{n}}} = P_b \frac{\cos^{\frac{1}{n}} 3\,M}{\cos^{\frac{1}{n}} M}$$

$$W = 2\,(P_b \cos M + P_c \cos 3\,M + \&c.)$$

$$W = 2\,P_b\left(\cos M + \cos 3\,M \frac{\cos^{\frac{1}{n}} 3\,M}{\cos^{\frac{1}{n}} M} + \&c.\right)$$

$$W = 2\,P_b\left(\cos M + \frac{\cos^{1+\frac{1}{n}} 3\,M}{\cos^{\frac{1}{n}} M} + \&c.\right) \quad \text{(ii)}$$

$$W = K_2 P_b$$

From which the load P_b on the ball b can be calculated. Then the corresponding approach of the rings δ as compared with the approach δ_1 when there is only one ball under the same load W is—

$$\frac{\delta_b}{\delta_1} = \left(\frac{W}{K_2 P_1}\right) \text{ and } \delta_b = \left(\frac{1}{K_2}\right)^n \delta_1.$$

This is the radial approach along the line passing through the ball b. The corresponding vertical movement is

$$\delta = \frac{\delta_b}{\cos \frac{a}{2}} \quad \text{Hence } \delta = \left(\frac{1}{K_2}\right)^n \frac{\delta_1}{\cos \frac{a}{2}}$$

From the above expressions P_a in Fig. 4 and P_b in Fig. 5 are readily found, also the approach of the rings when under load.

Two Balls.—Loaded as in Fig. 5.

$M = 15°$. $W_2 = 2\,P_b \cos 15 = 1{\cdot}93\,P_b$

$K_2 = 1{\cdot}93$

$$\delta = \left(\frac{1}{1{\cdot}93}\right)^{0{\cdot}757} \frac{\delta_1}{0{\cdot}966} = 0{\cdot}63\,\delta_1 \Big\} \text{Old bearing}$$

By experiment $\delta = 0{\cdot}69\,\delta_1$

For the new bearing $\delta = 0{\cdot}64\,\delta_1$ (calculated)

and $\delta = 0{\cdot}69\,\delta_1$ (experiment).

The reason why the experimental value is greater than the calculated is not evident, but it may be due to the distortion of the races. There was distinct hysteresis in both bearings.

Three Balls.—Loaded as in Fig. 4.

$$W_3 = P_a\{1 + 2\,[\cos^{2{\cdot}321}\,30]\} = 2{\cdot}43\,P_a$$

$$\delta_3 = \left(\frac{1}{2{\cdot}43}\right)^{0{\cdot}757} \delta_1 = 0{\cdot}51\,\delta_1 \Big\} \text{Old bearing.}$$

By experiment $\delta_3 = 0{\cdot}62\,\delta_1$

For the new bearing $\delta_3 = 0{\cdot}52\,\delta_1$ (calculated)

and $\delta_3 = 0{\cdot}57\,\delta_1$ (experiment).

Four Balls.—Loaded as in Fig. 5.

$$W_4 = 2\,P_b\left(\cos 15 + \frac{\cos^{2{\cdot}321}\,45}{\cos^{1{\cdot}321}\,15}\right) = 2{\cdot}87\,P_b$$

$K_2 = 2{\cdot}87$

$$\delta_4 = \left(\frac{1}{2{\cdot}87}\right)^{0{\cdot}757} \frac{\delta_1}{0{\cdot}966} = 0{\cdot}47\,\delta_1 \Big\} \text{Old bearing.}$$

By experiment $\delta_4 = 0{\cdot}58\delta_1$

For the new bearing $\delta_4 = 0{\cdot}48\,\delta_1$ (calculated)

$\delta_4 = 0{\cdot}52\,\delta_1$ (experiment).

Five Balls.—Loaded as in Fig. 4.

$$W_5 = P_a\,[1 + 2\,\{\cos^{2{\cdot}321}\,30 + \cos^{2{\cdot}321}\,60\}]$$

$$W_5 = 2{\cdot}84\,P_a$$

$$\delta_5 = \left(\frac{1}{2{\cdot}84}\right)^{0{\cdot}757} \delta_1 = 0{\cdot}45\,\delta_1 \Big\} \text{Old bearing.}$$

By experiment $\delta_5 = 0{\cdot}54\,\delta_1$

No test was carried out on the new bearing under these conditions.

Six Balls.—Loaded as in Fig. 5. Complete bearing :—

$$W_6 = 2\,P_b\left(\cos 15 + \frac{\cos^{2{\cdot}321}\,45}{\cos^{1{\cdot}321}\,15} + \frac{\cos^{2{\cdot}321}\,75}{\cos^{1{\cdot}321}\,15}\right)$$

$$W_6 = 2{\cdot}86\,P_b$$

$$\delta_6 = \left(\frac{1}{2{\cdot}86}\right)^{0{\cdot}757} \frac{\delta_1}{0{\cdot}966} = 0{\cdot}46\,\delta_1 \Big\} \text{Old bearing.}$$

By experiment $\delta_6 = 0{\cdot}56\,\delta_1$

For the new bearing $\delta_6 = 0{\cdot}47\,\delta_1$ (calculated)

and $\delta_6 = 0{\cdot}51\,\delta_1$ (experiment).

Complete Bearing with a Linoleum Liner between the Outer Ring of the Bearing and the Housing Ring A.—Experiments with ball bearings when running show that the life of the bearing is materially greater when a strip of linoleum or other soft material is interposed between the outer ring of the bearing and the housing. It was expected that these experiments would show that, owing to the distortion of the outer ring when thus mounted, the load would be more evenly distributed over the balls ; that is to say, the side balls would take more, and the most heavily loaded ball less, load than when a rigid housing was used. The experiments, however, have not borne this out. A comparison of the two curves of approach are of interest in showing the effect of the soft backing (see Fig. 6). In the case of the roller bearing the loading was carried up to 20,000 lb. by 2,000-lb. increments ; only three points of observations come on the diagram Fig. 6.

TABLE I.

Relation between the calculated and the experimental approach of the rings ; the calculated being taken as 1.

Number of Balls.	Old Bearing.	New Bearing
2	1·10	1·08
3	1·21	1·10
4	1·23	1·07
5	1·21	No test
6	1·21	1·10
6 with lino	No Test	1·15

The exact reason why a linoleum-backed bearing has a longer life than one rigidly housed must therefore be attributed to some other cause. Possibly the soft backing acts as a cushion and reduces the effect of vibration and impact on the balls, and, moreover, allows the bearing to adjust itself if there is any want of alignment between the bearing and shaft.

Summary of Ball-Bearings Tests.—The approach of grooved rings relatively to the approach of two flat surfaces when separated by a ball and loaded is 0·46 in the old bearing and 0·47 in the new. These relations are not constant for all loads ; the above values are for usual working conditions.

In Stribeck's original paper on the distribution of the load in ball bearings he gives the following table :—

TABLE II.

m	10	15	20
$\frac{360°}{m}$	36°	24°	18°
$\frac{W}{P_a}$	2·28	3·44	4·58
$m \div \frac{W}{P_a}$	4·38	4·37	4·36

$$\text{or } P_a = \frac{4{\cdot}37\,W}{m}$$

and to allow for the case in which there is shake in the bearing he takes

$$P_a = \frac{5\,W}{m}$$

The above table is worked out on the assumption that the approach of the rings when separated by a ball follows the same law as the approach of two flat plates. It is of interest to see how nearly the above agrees with ball bearings having grooved rings.

TABLE III.

m	10	12	15	20
$\frac{360°}{m}$	36°	30°	24°	18°
$\frac{W}{P_a}$	2·38 old 2·34 new	2·83 old 2·81 new	3·56 old 3·52 new	4·74 old 4·69 new
$m \div \frac{W}{P_a}$	4·21 old 4·27 new	4·25 new 4·28 old	4·21 old 4·27 new	4·22 old 4·27 new

The mean values being

$$P_a = \frac{4{\cdot}22\,W}{m} \quad \text{old bearing}$$

$$P_a = \frac{4{\cdot}27\,W}{m} \quad \text{new bearing.}$$

Table I shows that the experimental approach of the rings in an old bearing is greater by 21 per cent. than the theory indicates, therefore our expression becomes for a bearing in which there is a shake, and

$$P_a = \frac{4{\cdot}22 \times 1{\cdot}21\,W}{m} = \frac{5{\cdot}1\,W}{m}$$

which is a close experimental corroboration of Stribeck's value of $\frac{5\,W}{m}$.

For a new bearing with no appreciable shake the experimental approach of the rings is 10 per cent. greater than theory indicates, and

$$P_a = \frac{4{\cdot}27 \times 1{\cdot}1\,W}{m} = \frac{4{\cdot}7\,W}{m}$$

against Stribeck's

$$\frac{4{\cdot}37\,W}{m}$$

Roller Bearings.—Tests similar to those described above were made on a short-roller Hoffmann bearing. This bearing had been under test for over a year under heavy loads, but there was no shake in the bearing. The following are the essential particulars of the bearing tested :—

Number of rollers	14
Diameter of rollers	1 in.
Length of rollers	1 in.
Outside diameter of bearing ...	8·1 in.
Inside diameter of ring	6·85 in.
Diameter of bore	Same as ball bearings

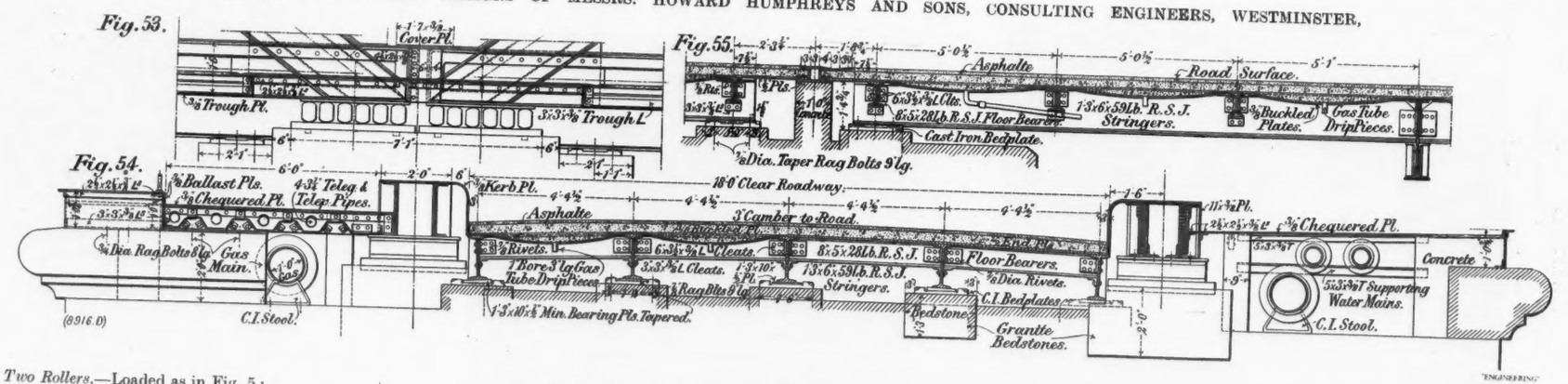
Approach of Two Rings when Separated by a Roller.—Let δ be the approach of the rings in inches when separated by one roller ; P be the load on the roller in pounds weight. Then the experimental results may be represented by the expression

$$\delta = \frac{P^{0{\cdot}935}}{910{,}000} = \frac{P^{\frac{1}{1{\cdot}07}}}{910{,}000}.$$

Thus the approach of the rings follows much more nearly a straight line law than in the case of a ball bearing.

THE NEW SHOREHAM BRIDGE OVER THE ADUR.

CONSTRUCTED TO THE DESIGNS OF MESSRS. HOWARD HUMPHREYS AND SONS, CONSULTING ENGINEERS, WESTMINSTER.



Two Rollers.—Loaded as in Fig. 5 :—

$$M = 12° 52'$$
$$W_2 = 1{\cdot}95\ P_b$$
$$\delta_2 = 0{\cdot}55\ \delta_1$$
By experiment $\delta_2 = 0{\cdot}50\ \delta_1$

Three Rollers.—Loaded as in Fig. 4 :—

$$W_3 = 2{\cdot}64\ P_a$$
$$\delta_3 = 0{\cdot}40\ \delta_1$$
By experiment $\delta_3 = 0{\cdot}40\ \delta_1$

Four Rollers.—Loaded as in Fig. 5 :—

$$W_4 = 3{\cdot}18\ P_b$$
$$\delta_4 = 0{\cdot}35\ \delta_1$$
By experiment $\delta_4 = 0{\cdot}36\ \delta_1$

Five Rollers.—Loaded as in Fig. 4 :—

$$W_5 = 3{\cdot}396\ P_a$$
$$\delta_5 = 0{\cdot}32\ \delta_1$$
By experiment $\delta_5 = 0{\cdot}32\ \delta_1$

Six Rollers.—Loaded as in Fig. 5 :—

$$W_6 = 3{\cdot}545\ P_b$$
$$\delta_6 = 0{\cdot}314\ \delta_1,$$
No experiment made.

Seven Rollers (complete bearing).—Loaded as in Fig. 4 :—

$$W_7 = P_a \left(1 + [\cos^{2{\cdot}07}\ 25°43' + \cos^{2{\cdot}07}\ 51°26' + \cos^{2{\cdot}07}\ 77°9']\right)$$
$$W_7 = 3{\cdot}48\ P_a$$
$$\delta_7 = \left(\frac{1}{3{\cdot}482}\right)^{0{\cdot}955} \delta_1 = 0{\cdot}31\ \delta_1$$
By experiment $\delta_7 = 0{\cdot}32\ \delta_1$

The agreement between the experimental and the calculated values is much closer in the case of the roller bearing than in the ball bearing, doubtless due to the fact that there was no shake in the former; the fit, indeed, was so good that the outer ring had to be worked to and fro in order to assemble the bearing.

Table IV in the next column corresponds to Table III for ball bearings.

If there were slack in the bearing the constant in the numerator 4·05 W would doubtless be greater, but not so high as in the ball bearing.

TABLE IV.

m	10	14	15	20
$\frac{360}{m}$	36°	25°43′	24°	18°
$\frac{W}{P_a}$	2·46	3·48	3·70	4·93
$m \div \frac{W}{P_a}$	4·06	4·02	4·05	4·06

Thus $P = \frac{4{\cdot}05\ W}{m}$

The above-mentioned experiments appear to show that Stribeck's expression, although based on data differing materially from that obtaining in modern ball bearings, gives results agreeing well with experimental values. In the case of roller bearings the proportional load on the most highly stressed roller is about four-fifths of that on a similarly placed ball in a ball bearing.

The author wishes to thank the Department of Scientific and Industrial Research for a grant for assistance and apparatus; Professor David, D.Sc., for kind permission to use the testing plant in the Engineering Laboratory at the Leeds University; also the Hoffmann Manufacturing Company for presenting the bearings.

ROYAL AIR FORCE DISPLAY.—The sixth Royal Air Force Display (formerly known as the Aerial Pageant) will be held at the Hendon Aerodrome, on Saturday, June 27, and will be attended by Their Majesties the King and Queen. It is intended to illustrate the progress of war flying by "using evolutions" which will be carried out by four day-bombing squadrons and by "flight evolutions," conducted by single-seater fighting machines. Squadron drill carried out by means of wireless telephony, will also be demonstrated, the orders being given by the squadron leader from his machine, while in the air. Over 100 aircraft, drawn almost entirely from Home-Defence units, will take part in the display.

BRIDGE RECONSTRUCTION WORK OF THE MINISTRY OF TRANSPORT. No. IV.

UP till 1832 the estuary of the River Adur in Sussex was spanned only by an old timber bridge built under an Act of Parliament of 1781. In 1832, however, the Norfolk suspension bridge was opened. It had been built by Tierney Clark, a pupil of Telford's, who had considerable experience in the construction of such bridges, having been engaged on those at Budapest, Hammersmith and Great Marlow. The Norfolk bridge was a toll bridge, and was purchased from the Duke of Norfolk in 1903 by the West Sussex County Council. The rapid growth of mechanical transport gave rise to anxiety as to the condition of the structure, and in 1914 Messrs. Howard Humphreys and Sons, Consulting Engineers, were asked to report on the matter. A detailed examination showed that the bridge was defective in a good many respects, and the seriousness of the matter was increased by the fact that the cross girders were of cast-iron and were overstressed even by the dead load. Some, in fact, were already cracked through. In addition, the action of the sea water on the suspension chains had corroded some of the links to the extent of almost one-third of their section. The timber decking was found to be very unsound, and the saddles on the piers were immovable, largely owing to rust and faulty design.

Much as it was desired to retain this handsome structure in at least its main features, this detailed examination made it evident that it was economically impossible to render the bridge really adequate to modern traffic, and it was decided accordingly to instruct the consulting engineers, in conjunction with Mr. H. W. Bowen, M.Inst.C.E., the County Engineer, to replace it by a bow string girder bridge capable of taking the heaviest loads now to be found on our highways. Wherever practicable it is now customary to build highway bridges as deck structures, since it is then easier to provide the requisite strength in the floor. In this instance, however, considerations of levels and head room made it necessary to design the new work as a through bridge. The suspension bridge had a span of 280 ft. between centres of towers, and it was decided to utilise the existing piers for the new structure, and to build an additional pier half way between the two. The latter were also enlarged, and the abutments were reconstructed. The stone required was obtained so far as possible from the dismantled work.

The new bridge has two centre spans of 128 ft. each in the clear, and two side spans of 118½ ft. each. An elevation is given in Fig. 35 and a plan in Fig. 36, Plate XLVIII, with this issue. It will be seen that each span has two main trusses spaced at 21-ft. centres, thus giving a clear roadway of 18 ft. in width. In addition, there are two 6-ft. side walks, which are supported on cantilever extensions of the cross girders beyond the main trusses. These main trusses measure 136 ft. 8 in. between bearings in the case of the central spans, and the depth is 21 ft. at mid length. The trusses for the two side spans are 127 ft. 8 in. long between bearings, and the depth at mid length is 18 ft. 1½ in. Details showing the construction of these side span trusses are reproduced in Figs. 38 to 45, Plate XLVIII, whilst a cross-section showing the upper lateral bracing between the trusses is reproduced in Fig. 46. The junction between the main trusses and this cross bracing is illustrated in Figs. 47 and 48.

The construction of the bridge floor is shown in Figs. 49 and 50, whilst Figs. 51 and 52 give details of the joints between the cross girders and the longitudinal stringers. These latter consist of 15-in. by 6-in. rolled steel joists, and have riveted to them 8-in. by 5-in. steel I-beams, which serve as intermediate bearers. The whole space between successive cross-girders is thus divided up into rectangular cells, which are bridged by the ⅜-in.

THE RECONSTRUCTION OF SHOREHAM BRIDGE.

FIG. 60. WORTHING PIER FROM NORTH END; SHOWING STIFFNESS OF JOINTS IN OLD CHAINS.

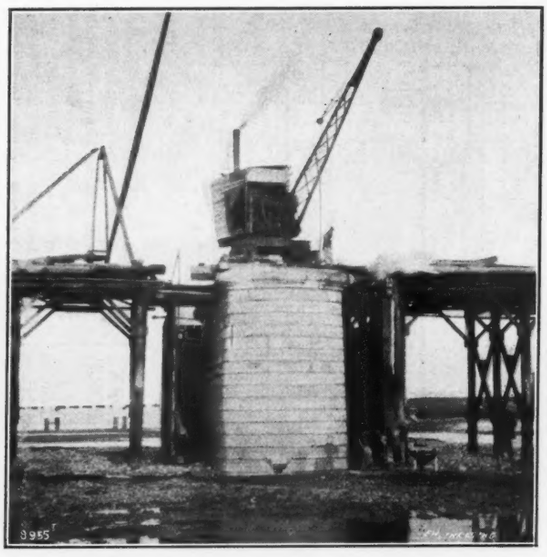


FIG. 61. STRIPPING OF COFFERDAM; SHOWING NEW PIER AT LOW WATER.

buckled plates, which support the roadway. The side paths are carried on steel troughing, as indicated, and sufficient space is found within its depth for the two 6-in. water mains shown on the one side, whilst on the other a number of 3¼ in. telegraph and telephone pipes are similarly accommodated as will be seen on reference to Fig. 54, page 755. Under each side path there is also a 12-in. gas main, which is carried through 14-in. holes in the web plates of the cantilevers.

To provide for expansion, each end of the main trusses is supported on roller bearings of the type indicated in Fig. 53. A sliding joint is provided in the roadway over the centre of each side pier, as represented in Fig. 55. Here it will be seen the overhanging steel work of the roadway is supported directly by a concrete pedestal, which extends right across the pier. There is, as shown, a 3-in. interspace between the two opposing ends, which is covered by a flap plate. At each side pier the longitudinals of the floor are arranged to slide on cast-iron bearing plates. Tapered shims are provided between plate and joist, as indicated, in order to give the tilt required to accommodate these longitudinals to the curvature of the roadway.

As already mentioned, the condition of the old bridge was known to be precarious in 1914, but it was not possible to proceed with the work of reconstruction till after the war. Still further delay arose because of the impossibility of getting satisfactory tenders for the work in the immediately succeeding years, and it was therefore decided that in order to enable traffic to continue the use of the bridge and to avoid a very long detour, which its closure would have involved, timber false-work should be built up underneath to support the cross girders. This false-work would serve as a support for the deck of the existing bridge when the new bridge came to be built, and as a working platform, when the suspension chains had been cut down. This arrangement proved to be very satisfactory. This temporary timber work is shown in place in Fig. 56, page 768. Tenders for the actual reconstruction were invited early in 1922 and the work was commenced soon after.

The reconstruction presented certain features of interest. For example, it was found that the towers carrying the saddles of the chains were reinforced with iron rods running up through the massive stones, and this fact caused a good deal of difficulty in the dismantling of the towers. Another point of interest was that the suspension links were so rusted together at the joints that when the chains were cut through several links would stand out stiffly at an angle of about 30 deg. with the horizontal and without any support. This is well shown in Fig. 60 above, where parts of the chain can be seen standing out stiffly in spite of the fact that the free ends are unsupported. Attention may also be called to the portion of the chain immediately over the tower. From this it will be seen that the links of the chain were bent to fit the saddle.

FIG. 62. OLD CANTILEVERED CAST IRON GIRDERS.

The erection of the steelwork presented no very great difficulty, as it could be built up on the deck of the old bridge, which was carried by the false-work. When the main girders were riveted together the cross girders were threaded in and the timber false-work and deck of the old bridge were removed. The new spans could then be lowered into position by hydraulic jacks. The steel work took only four months to erect, and the whole of the work was done in 11 months by the Unit Construction Company, the steel being supplied by Messrs. E. C. and J. Keay. A number of photographs taken during various stages of the work are reproduced in Figs. 56 to 59, page 768, and in Figs. 60 to 62 above, and in Figs. 63 and 64, page 757. The foundation work for the new central pier is illustrated in Fig. 58, which shows the interior of the cofferdam. A view of this pier practically complete is reproduced in Fig. 61, and from this it will be seen that at low water the foundation is dry. The cantilever extensions of the old cast-iron girders of the original bridge are shown in Fig. 62 above, whilst the work of concreting the new roadway is shown in progress in Fig. 63, page 757; Fig. 64 is a representation of the completed structure of the new bridge as viewed from the west end.

The estimated cost of the bridge was 45,034*l.*, and a grant of 19,890*l.* was made by the Ministry of Transport. (A saving of 1,500*l.* was made during the construction of the work.) By the terms of the West Sussex County Council Bridges Act, 1918, the bridge will become free at latest after 50 years from the date of the Act, or when a sufficient sum has

THE NEW BRIDGE AT SHOREHAM.

FIG. 63. CONCRETING THE NEW ROADWAY.

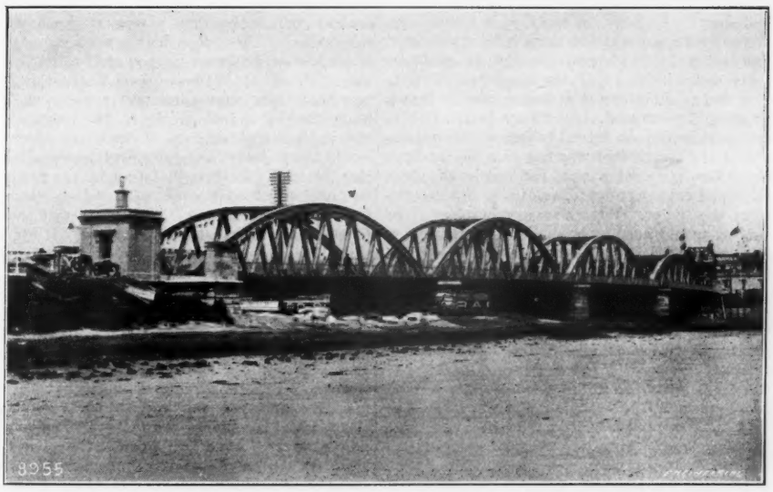


FIG. 64. VIEW OF BRIDGE FROM WORTHING END.

accumulated under the financial provisions of the Act for the discharge of the bridge debt and other purposes. The grant from the Ministry will have the effect of hastening the time when the bridge will become free from all tolls.

THE INSTITUTION OF GAS ENGINEERS.

(*Concluded from page* 741.)

THE meetings were resumed on Wednesday morning, June 10, when Mr. J. Ferguson Bell again presided. After the announcement of the election of new members and their introduction to the President, Mr. R. H. Ruthven presented the report of the Wrought Iron Tubing Committee. In this report it was stated that it was desirable that steps should be taken by the gas industry to ensure that the gas barrel supplied should be composed only of superior quality wrought iron. For the attainment of this purpose, it was desirable that the services of a metallurgist be made available in drawing up a specification and prescribing tests for piping. Attention was directed to a simple etching test for the rapid differentiation of steel from wrought iron. An important point brought out in the report was the very deleterious effects produced on gas barrels, whether made of iron or steel, by the presence of carbonic acid, oxygen and water vapour in the gas. All practical means to reduce the amount of oxygen in the gas to a minimum, the Committee suggested, should be adopted. Some few questions were asked by members, which showed the interest taken by gas engineers in the subject, and Mr. Ruthven was thanked for the manner of his presentation of the work that has so far been performed.

STANDARDS OF ILLUMINATION.

Mr. Robert Watson, one of the Institution delegates to the International Commission on Illumination, then presented a report on the sixth session of this body. In this were summarised the various papers submitted by the delegates to the Commission and the views of other members. Dr. Ives, it was stated, had suggested that the standard of light should be the brightness of a black body at the melting point of platinum. From tests with 46 cylinders made with blackened platinum, it was found that a mean value of 55·39 candle-power per square centimetre was obtained. Twenty-three measurements made by the photo-electric method gave a mean value of 55·41 candle-power per square centimetre, and consequently, a final value of $55{\cdot}40 \pm 0{\cdot}11$ candle-power per square centimetres was accepted on the value of the brightness of a black body at the melting point of platinum. A recommendation was made in this paper that the standard there described should be adopted as a primary standard because of its many advantages. In another contribution, M. Fleury indicated the methods of the work, and the preliminary results obtained in the endeavour to obtain a standard of luminous intensity. He proposed to use a high temperature furnace consisting essentially of a carbon tube heated electrically and traversed by a current of nitrogen. Owing to the growth of fast road traffic, it has become necessary to establish standards for street lighting. As indicating the variation in the views of different authorities on this matter, it was shown that the American Illuminating Engineering Society prescribed that the light value should not be less than 0·001 ft.-candles, while the London "Safety First" Council adopted a value of direct illumination of 0·05 ft.-candles, or a horizontal illumination of 0·004 ft.-candles, and the National Physical Laboratory authorities indicated that a direct illumination of 0·1 ft.-candles was necessary.

The only suggestion made in the discussion was that of Mr. Davis, that gas engineers should study the value of reflectors as had been done by the electrical engineers in perfecting directive lighting. Great advantage had been obtained by the electrical engineers through the work, and other engineers who had to study the lighting requirements of the public should apply themselves equally to the task.

RESEARCH ON REFRACTORIES.

The report of the Joint Refractories Research Committee was then presented by Mr. J P. Leather. This consisted of a collection of papers by various authors. The test of refractories, as revised in 1923, was found to be far from satisfactory in practice, and after much discussion and experimental work it had been decided to introduce a new test as "The Gas Engineers' Refractoriness Safety Test." This test was intended to determine whether the material showed signs of fusion at a specified temperature. The Committee were not yet satisfied that they had reached the stage when it was possible to regard the tests as fixed and were undertaking further investigations.

Sir Arthur Duckham said that the maintenance of carbonising plant was the major factor in the cost of working. As an industry, they did not quite realise yet the value of research on refractories although individual manufacturers were spending large sums in finding solutions for the problems involved. They needed some means of bringing all the available information together and co-ordinating it for the benefit of the gas producers Mr. T. F. E. Rhead followed in the discussion, and said that he was surprised that the manufacturers were rarely asked to supply refractory materials to any specification. The new test had two important functions, to determine whether a material had any claim to be regarded as a refractory, when tested under standardised conditions, and to enable the purchaser to have a test which could be performed quickly, and afforded a reliable check on the unchanging quality of the material. Variation was due to excessive grinding of silica, causing contamination with the iron from the pans. Carelessness might be shown in mining or quarrying the raw material, too much fine dust might be left in the refractory substance and inaccurate mixtures might result from the neglect to use suitable proportioning machinery. Mr. Frank West then referred to the work done by the Ceramic Society. A demand for a simple test by fusing a hole in the material was made by Mr. Williams, and Mr. Gill called attention to examples of retort settings he had seen in America, which had been in continuous use for nine years.

Mr. J. P. Leather, in reply, agreed with Sir Arthur Duckham on the necessity of bringing together all the information available. The most useful information was derived from the investigation of failures. Much information had been given to the Committee by Sir Arthur Duckham, who had placed the books containing the records of his tests at their disposal. They had also the valuable work of Mr. Rhead, of Birmingham. It was surprising how few people used the specifications for refractories. There was little possibility of

obtaining a simple test of any value. Expansion troubles with silica, when subjected to high temperatures, were common. If expansion had to be cut down they had to find a material that was well fired and was uniform in quality throughout.

A luncheon in connection with the annual meeting was given at the Royal Automobile Club at which Mr. J. Ferguson Bell presided and the principal guests were Sir Philip Cunliffe-Lister, President of the Board of Trade, Mr. J. H. Thomas, Major-General Sir R. H. Luce, Mr. Charles F. Botley, Sir Dugald Clerk, Mr. W. H. Patchell, Dr. Charles Carpenter and Brig.-General Magnus Mowat.

Gas Calorimetry.

At the afternoon meeting Professor C. V. Boys, F.R.S., presented a paper on "Developments in Gas Calorimetry." In this contribution the author first referred to the well known "Block" calorimeter, in which use was made of the nitrogen-filled rubber material known as "onazote," not only as a heat insulator but also as the water containing material to replace metal for the purpose. After some years of use this application of "onazote" was found to lead to irregularities in the results. Water flow calorimeters were costly, and their use entailed somewhat more elaborate procedure to obtain good results than could be undertaken in the small gasworks. Professor Boys, as a Gas Referee, had designed a self-contained "Box" calorimeter, and it was this instrument which he described. In this apparatus the water required for the test is contained in a small tank raised above the rest of the apparatus by being placed on a stool on the gas tester's bench. After passing through the calorimeter it is received in a similar tank below the bench. As the same water is used over and over again there is no need for a continuous supply, which may contain impurities, which would affect the readings. A hand pump suffices to raise the water to the top tank whenever necessary. The water in use for the tests will have attained the temperature of the room before the start of the test. The usual overflow system of regulating the rate of passage of the water through the calorimeter has been replaced in this instrument by a float system such as is used in carburetter design. The gas to be tested is brought from the service pipe to an efficient governor, then to a Tee pipe where one portion of the gas passes to a clearing burner so that the gas tested is not that lying dormant in the pipe. The other branch of the Tee leads through a micrometer tap to a Boy's Bell meter and so to the burner. This burner consists of a narrow inner tube terminating within a plain parallel silica tube open above and below, which can be moved down when necessary to permit the lighting of the gas jet. As the gas is somewhat ærated before combustion it is possible to burn as much as 1 cub. ft. an hour without the risk of imperfect combustion. The hot gases rise up to a silica dome and descend within the usual lead interchanger of the type used in the Boys' recording instrument, and then, entering an annular lead bowl, are led down through the bench with the condensate, produced from the burning of the hydrogen in the gas, by means of a lead duct. It is merely necessary with this instrument for the gas examiner to find the position of the micrometer tap that will allow of the intended number of complete turns of the meter drum while the water used is filling a flask up to some definite mark in its neck. This setting once made may be repeated with only such small variations as may be convenient from day to day. As the exit water attains its final temperature in a quarter of an hour and no after adjustments are necessary, the work of the examiner is greatly reduced with this new calorimeter. The Bell meter used was designed to overcome the sticking sometimes characteristic of the ordinary test meter. This Bell meter has a celluloid or nickel drum, the axle of which moves in bearings in the water of the meter. A buoyancy chamber is introduced to support the weight of the drum and forms a solid floor to the major part of each compartment at the critical moment at which a charge of gas is trapped within it. Leakage is impossible as the drum is covered with a glass bell making a joint with the bowl of the instrument below the water level, and this makes the view of the drum possible at all times.

Mr. Whipple said he was greatly impressed with the way that Professor Boys had got over the radiation difficulty with calorimeters. He wondered if the author had thought of using kieselguhr as an insulator, for it had the advantage of possessing very small air spaces within it. It was extraordinary that no one had thought of constructing a calorimeter to be slowly filled with water at a definite rate. It was of interest to them all that Professor Boys had in the last twelvemonths been presented with the Rumford and Duddell Medals for his experimental work. Dr. Coleman referred to the determinations with gas which had been stored in a sampling device. On this point they were not yet able to say anything definite, but tests had shown that in an arrangement where the temperature was kept constant no loss had been recorded which was more than 1 per cent. Mr. J. W. Wood said he saw no reason for deterioration of the sample in the new calorimeter. Dr. Smith was surprised that emphasis was made of the suitability of the instrument for small works. Were it put to service in the large works, the chemists could undertake more valuable work. Dr. Parker called attention to the water lute in the instrument, which might cause inaccuracies through solubility, and there were also possibilities of diffusion of the gas. Mercury might prove more suitable. The drawing of samples at predetermined rates would seem to be difficult if the main supply was varying.

Professor C. V. Boys, in reply, said he had not tried kieselguhr and did not think that it possessed any advantage over compressed cork as an insulator. The gasometer in his apparatus was regulated in its motion and could only rise as fast as the clockwork controlling it permitted. In answer to Dr. Smith, he said that he did not intend to convey the impression that the instrument was not suitable for large works. The gasometer was not made of sheet steel, but of copper or brass, and it did not deteriorate in the water. Were mercury employed the gasometer would need to be made of iron and consequently would be much heavier. As he had not used the instrument for a long period, say three months, he could not say if there were any troubles due to solubility in the water or to diffusion. In a fortnight's test on his own local supply he had experienced no difficulties.

Examination of Special Cokes.

Professor Cobb then presented a report prepared by himself with Mr. C. B. Marson on "The Preparation and Preliminary Examination of Special Cokes" as the first work in an investigation on the "Influence of the Ash Constituents in the Carbonisation and Gasification of Coal, with Special Reference to Nitrogen and Sulphur." In this communication, as was pointed out at the meeting by Mr. Marson, the authors had endeavoured to discover the effects of additions of measured quantities of ash to a particular type of coal prior to coking it. The most remarkable changes in the physical character of the cokes was brought about by the presence of oxide of iron and alkali. The oxide of iron case gave coke which was smaller in bulk, more compact in structure, finely porous, and more resistant to crushing than that obtained from the pure coal. Caustic alkali destroyed the coking properties, while sodium carbonate gave a compact, finely porous coke, particularly resistant to crushing.

Dr. Lessing, in opening the discussion, called attention to the enormous influence of the ash in carbonisation processes. The results generally confirmed his own observations. All work on carbonisation would have to be reconsidered in the light of the inorganic constituents of the coal. They would like to have the values of the actual coke yields from the various mixtures. Results of crushing tests on small pieces of coke must be regarded with caution, as was pointed out by the authors.

Town Gas for Motive Power.

The meetings were resumed on Thursday morning, June 11, when Sir Dugald Clerk, F.R.S., contributed a paper entitled "Note on Town Gas for Motive Power." At present, said the author, about 10 per cent. of all the town gas manufactured and distributed in Great Britain and Ireland was used to produce motive power. The total was approximately 360,000 brake horse-power, or about one-half of all the stationary internal combustion engines in our factories. Gas engine efficiency remained practically constant from 5 to 100 brake horse-power, and this enabled the smaller engines to work more economically than steam engines of similar power. It was true that gas engines were run on town gas at powers of 150, 300, 450 and 1,000 brake horse-power with complete engineering success, but the fuel cost was too great at the usual selling price of town gas to lead to general use in cities. If town gas could be obtained at a sufficiently low price per therm, gas engines of every power would be run on it. At present the price, 4*d.* to 6*d.* per therm, was too high to compete with other sources of power above 100 brake horse-power. The comparison of the results obtained with various fuels showed that for a 50 brake horse-power engine, town gas worked out at 0·75*d.* per brake horse-power-hour, while anthracite suction gas gave 0·52*d.*, coke 0·49*d.*, and Diesel crude oil 0·47*d.* Even the small gas power trade might be held against the competition of the electricity supply people if the gas companies would decide to let out gas engines on hire in the same way as they commonly did with stoves.

The President, Mr. J. Ferguson Bell, referred to the fact that the Derby Gas Company decided twenty years ago to institute a hire-purchase system for gas engines, but had now started a system of simple hire. They also had a service system by which the engines were kept in good running condition. Mr. R. D. Walmsley called attention to the fact that there were some power users who must have electricity, such as the textile industries, for the independent driving of their machines. He would like to have the figures for the cost of generating electricity in these instances by the power of a gas engine as contrasted with taking electricity from a supply company. They must suit the price to sell gas to compete in that way. It appeared that the electricity supply bodies charged for power at much lower terms than for lighting, and even at less than the average cost of generation. Mr. Shadbolt suggested it was "immoral" as a business proposition to overcharge electric light users in order to undercharge electric power users. Actually the electric motor had the characteristics of easy control and the possibility of individual drives for machines, and these were more important in competition with gas engines than the mere price of the power supply. Dr. Smith ridiculed the suggestion of the term "immoral" being applied to the electric supply undertakings, who had carefully studied the commercial issues involved in power supply and found that their differential rates were productive of business. There was no philanthropy in power supply, and the sooner the gas engineers studied their business methods with the same thoroughness as the electrical engineers the better it would prove to be for their industry. An inquiry by accountants into these matters should be instituted. Mr. W. A. Tookey thought Sir Dugald Clerk had not treated the questions involved in the use of town gas as he might. Better figures could be shown than those given for town gas in comparison with producer gas obtained from anthracite, because it appeared that nothing had been allowed for repairs and upkeep. Were it not for repairs, we should not find producers abandoned in favour of taking town gas supply. The service question in regard to gas engines was of vital importance to the gas industry.

Sir Dugald Clerk agreed with Mr. Walmsley regarding the importance of the separate electric-motor drives for machines, and instanced gas-engine makers, who adopted electric distribution from a station with gas engines driving the generators. He thought they should advocate the generation of electricity in works by the use of the gas engine using town gas. Dr. Smith was quite right when he suggested the necessity for an inquiry by accountants into questions of charging for gas supply for power purposes. Repairs were not so costly as was thought by Mr. Tookey; at any rate, the works figures did not bear out his views. When

Mr. Tookey explained that he was interested solely in users' figures, Sir Dugald Clerk called attention to the fact that they were not always reliable.

Economics of Gas Production.

Mr. George Evetts then presented a paper on "The Economics of Gas Production on the Thermal Basis." In this he discussed the relative costs of supplying the same number of therms with different qualities of gas; the factors influencing the choice of a declared calorific value of gas used; the demands of special trades; the type of coal available; the relative values of coal, oil, and residual products; the capacity, type, and condition of the carbonising plant and the other portions of the equipment, and the capacity of the distributing plant. He then discussed possible developments of new processes, the operating costs of equipment, and the capital costs where new plant was under consideration. He examined these various factors in turn, and showed the effects upon them if different types of gases were considered.

Mr. Marshall, whose process of low-temperature carbonisation had been referred to in the paper, said that if low-temperature carbonisation had to stand alone it had no reasonable prospect of economical success, but in association with the gas works of the country there was a great future for the process. He then referred briefly to some of the work he had done with his plant in making smokeless fuel and producing oil and residuals. Dr. Smith wanted an assurance that if the gas engineers were to take up low-temperature carbonisation, there was a reasonable chance of it proving a success from their standpoint. The paper afforded a good example of how they could investigate the economic position of their own gas-supply systems. In one part of the paper high-grade gas was advocated from the standpoint of distribution, while a gas of 360 B.Th.U. per cubic foot was thought best from the production standpoint. They might say that the average of these two extremes—say, gas of 440 B.Th.U. per cubic foot—would be the ideal, but the conditions for every station were different. Mr. Robinson thought that the only way to make a comparison between any two systems was to draw up complete balance sheets. Mr. Shadbolt then called attention to a statement in the paper which implied that thermal consumption would hardly vary, no matter what was the composition of the gas. This was not nearly the case when dealing with domestic consumers. In the last fourteen years the gas unaccounted for by purchase was 5·6 per cent., and was reasonably constant over that period. As the calorific value of the gas had been reduced from 550 to 400 B.Th.U. per cubic foot, the thermal loss had fallen. Mr. Morland spoke of the practice in Australia generally following that at home, although they did not yet sell on a basis of therms. The President then called upon the author to reply to the discussion, and asked him to define the terms high and low-quality gas.

Mr. George Evetts answered that he always considered a gas of over 500 B.Th.U. per cubic foot as of high quality, and one of below 400 B.Th.U. as of low quality. Mr. Marshall in his references to his carbonisation process seemed to be claiming the best results attainable under any conditions, varying for each factor, and not those which could be obtained under any definite fixed set of circumstances. Dr. Smith's comments on the comparisons in the paper not being absolute, but merely intended as indicative of how the questions could be dealt in the case of each system, were quite in agreement with what were his intentions. It was always found that complaints relating to gas were least where the calorific values were high. In regard to leakage, Mr. Shadbolt should recognise that in later years the quantity of gas sold had increased considerably.

After the customary votes of thanks, it was announced that Mr. Charles F. Botley, of Hastings, had been elected President, and Messrs. John Wilkinson, of Nottingham, and H. D. Madden, of Cardiff, were elected Vice-presidents. Mr. Botley then thanked the members for his appointment as President and presented to the retiring President, Mr. J. Ferguson Bell, the Presidential Certificate of the Institution. The meeting then closed.

LITERATURE.

Bituminous Substances. By Percy Edwin Spielmann, Ph.D., B.Sc. (London), F.I.C. London: Ernest Benn, Limited. (Price 15*s.* net.)

Bitumen may be the earliest known product of crude petroleum, though we rather doubt it; but it is certainly the least understood petroleum product from the chemical standpoint. Of the highly complex petroleum itself chemists do not claim to know much more than the hydrocarbons of low molecular weights and low-boiling points, the main constituents of motor spirit in fact. In bitumen the complexes of high molecular weights, including asphalt, seem to be concentrated to such an extent that the chemist has almost to be satisfied with group differentiation. As a chemist Dr. Spielmann had thus a difficult task in his work "Bituminous Substances," which covers scientific progress of practical importance during the last fifteen years. "That period roughly covers the rise of asphalt pavement into an important factor in the development of transport," Dr. Spielmann states in his preface, in which he acknowledges his indebtedness to Messrs. Highways Construction, Limited, and to his late colleagues in that firm. The development of carbonisation has undoubtedly been both detrimental and beneficial to our roads, and petroleum products have also remedied the damage which other petroleum products have done, as Mr. J. Kewley points out in his foreword to the volume. But the asphalt industry dates back much further than fifteen years, and was well established before tarred roads were adopted.

The volume is divided into six chapters, the first of which, an historical introduction, is faced by a Note to the effect that, as the subject of nomenclature is to be examined by an authoritative committee, the adoption of any definite scheme is undesirable. "For the present purposes, bitumen is considered to cover the softer substances usually assumed to have close relationship with petroleum and to be substantially soluble in carbon disulphide"; asphaltites are stated to be similar, but harder substances, and asphalt is said to consist of these substances intimately associated with considerable proportions of mineral matter. There is no mention of the fact that 22 pages of an appendix deal fully with the nomenclature. In Chapters II and III, on composition and origin and on properties, the author goes practically at once into group separation by various solvents, &c., without giving a general characteristic of bitumen. It is true that the properties of bituminous substances are very indefinite and inconstant, particularly because bitumen cannot be examined without some preliminary treatment. It must be admitted that bituminous substances are something of a nightmare to the investigator. As regards origin, Dr. Spielmann is doubtful whether, bitumen or petroleum, was first formed. But he considers that micro-organisms play a great part in the decomposition of organic matter into petroleum, and that colloidal carbon is the essential constituent of bitumen. He is not very happy in parts of his historical introduction. Statements that the human history of bitumen began 12,000 years ago with the late Stone Age man of the Mediterranean, that the impression left by the cataclysms which drove Atlantis below the Atlantic Ocean became associated with local inundations magnified into the Noachian Flood, and that it is difficult to extract trustworthy historical facts from the Bible are of questionable value or out of place. After quoting various writers as to the uses of bitumen in ancient times, by the Israelites and Egyptians and others, he adds a note that, according to Lucas, 1924, all the so-called bitumen found in mummies was resin.

For the engineer the chapters on "Effects of Heat," "Ageing and Solvents," "Physical and Chemical Tests" and the "Correlation of Properties" are, perhaps, the most interesting. These chapters dealing with density, fusion and firing points, viscosity, penetration, solubility in petroleum ether, fixed carbon, &c., embody a good deal of research work done by Dr. Spielmann. But the correlations deduced are not simple; most of the curves are not straight lines, and useful conclusions can scarcely be reached at present. We find much detail on the needles used in penetration tests; that they are known as Vicat needles is not mentioned. One thing seems clear. For most uses of bitumen—for painting, waterproofing, insulating, flooring and road-making—heating, or at any, overheating should be avoided so far as possible. Dr. Spielmann is a member of the Standardisation Committee of the Institution of Petroleum Technologist. If the volume, he has compiled, is likely to be of more interest to the investigator and testing expert than to the general reader, he has certainly taken pains to give a good account of our present knowledge of bituminous substances.

Manual of Locomotive Running Shed Management. By W. Paterson and H. Webster. London: Messrs. Charles Griffin and Co., Limited. [Price 15*s.* net.]

The authors of this work have succeeded in producing a manual in convenient form containing essential information for the efficient management of steam railway locomotive and carriage and wagon depots. The manual should be of great use to the junior officials, foremen in charge, and as a text-book by those concerned with the technical instruction of apprentices at the main locomotive works, and the instruction of classes of cleaners, firemen and drivers. For those of wider experience it presents a complete survey of this important branch of railway administration, and forms a reliable basis from which to consider further improvements. It should also be of service to many engineers in charge of works, collieries and contract schemes, having the care of their own locomotives, used for the transport of material from one site to another. Though not giving detailed descriptions of shop processes and operations many useful hints are contained in it. The book is well illustrated with diagrams and charts, and appended are a useful set of tables not generally met with in other publications. Having explained the organisation and grading of the staff, the care of the men is first dealt with, including the provision of first-aid stations, clubs, and the general welfare of the staff, both for their work and recreation. Classes for all grades are strongly advocated in order that each individual may thoroughly understand on the technical side what he is called upon to do daily in practice, and to give each an equal chance to step readily into a higher grade. Valuable hints are given on the form such courses should take, always with a view to encourage the individual to think for himself. System is essential in railway matters, and the lay-out of the running shed, which may be rectangular or round according to the preference of the engineer responsible, the space available, or requirements of working, must be thoroughly considered, so that the system of handling the locomotives for cleaning, light repairs, and heavy overhauls may be efficiently and expeditiously carried out.

In the lay-out of any new shed or the modernising of an old one, it is advantageous to have drawn up a reference list giving, in addition to the main requirements, all the minor details which might otherwise be overlooked until actually required. The position of the machine and fitting shops, smithy and stores in relation to the heavy and lighter repair siding is important. The machine shop and stores at a running shed are accessories to the main work, and reasonable judgment must be used about the quantity of equipment required.

In this volume the authors follow all the stages through which a locomotive passes, from going off work to returning to duty, both as regards cleaning and washing out. In washing out an engine a great amount of heated water and steam are usually lost. Several alternative schemes are in use for the blowing down of a boiler, and conserving as far as possible the heat which would otherwise go to waste. These are fully considered in the book. The necessary plant is adequately described and diagrams are given of the general lay-out. These plants not only supply hot water for washing out, but also a supply of hot water for filling up the boiler when the plugs, &c., have been replaced.

The question of working charts is gone into at

THE FIEUX CLUTCH FOR LOCOMOTIVES.

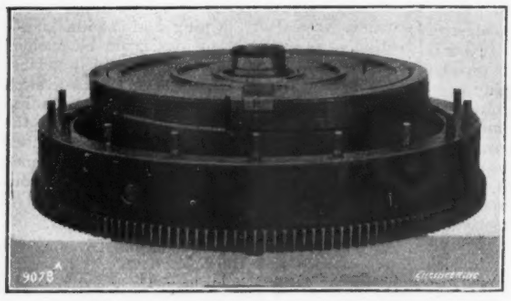


FIG. 1.

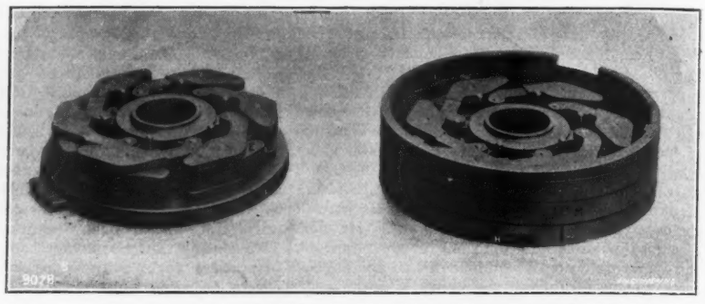


FIG. 2.

Fig. 3.

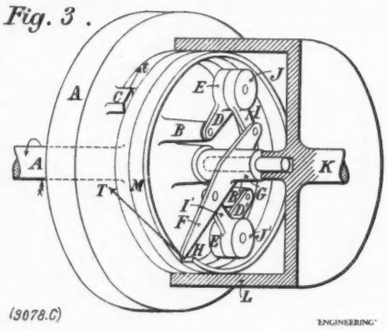


Fig. 4.

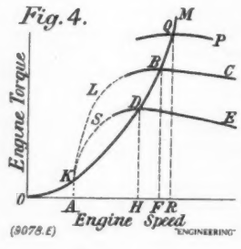
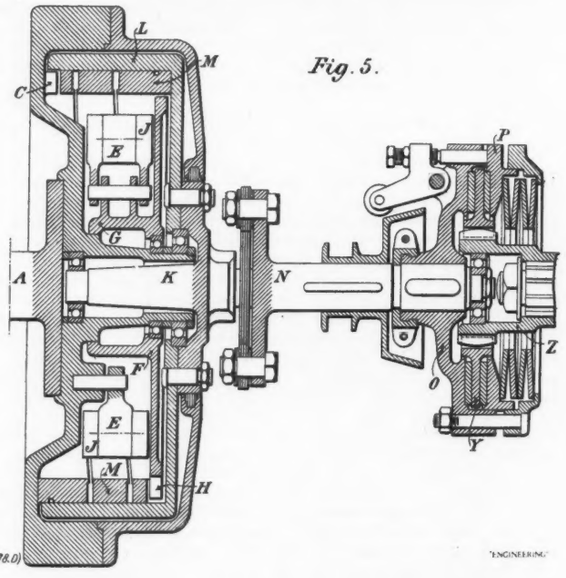


Fig. 5.



length, so that drivers, firemen and engines may be kept as fully employed as possible,

The organisation of the breakdown train, so that it shall be instantly available both in personnel and material needs to be well thought out, as it is essential that in case of breakdown, which is sure to occur sooner or later, the line may be cleared as speedily as possible, and the ordinary running of the line resumed. A chapter devoted to this subject contains a good deal of useful matter.

Many other points arise in the daily work of a running shed such as questions in connection with stores, water, coal and coaling plants, the best methods of stacking and storing coal, &c. On all these this manual will be found to provide much useful information in a compact and handy form.

Engine failures, examinations, and waste materials, are other subjects dealt with. Generally speaking, the information is well condensed and the attention given to the subjects is well balanced. Although not exhaustive the book is a substantial addition to the literature on the practical side of locomotive operation.

The Technology of Water. By ALAN A. POLLITT. *Organisation and Production.* By J. W. CURTIS. *Grinding and Crushing Machinery.* By HARTLAND SEYMOUR. *The Screening and Grading of Materials.* By J. E. LISTER. *Sulphuric Acid Concentration.* Vol. I. *By Hot Gases.* Vol. II. *In Heated Vessels.* By P. PARRISH and F. C. SNELLING. The Chemical Engineering Library. Second Edition. London: Ernest Benn, Limited. [Price 6s. net each volume.]

THE six volumes before us, with two exceptions perhaps, may be described as chemical engineering primers. Elementary books of this nature should be written by masters of their subjects. That is, of course, desirable for all books, but particularly so for introductory treatises, in which clear conception and broad outlook are more essential than in monographs on special lines of research and operation, which the specialist will be better able to present than the sound general scientist. When primers deal with special branches of chemical engineering we need, of course, a specialist, and the point then is to find somebody who does not forget the general purpose among the details, while sufficiently emphasising such detail as experience has proved to be essential. From this point of view, the two volumes on "Sulphuric Acid Concentration" which stand somewhat apart from the other volumes, can be recommended. They give a clear and broad insight into the technics of concentration, with adequate detail. But two volumes at 6s. merely on acid concentration makes the figure high for such a work.

This brings us to our second point. The student will need books on a variety of subjects, and we can hardly expect him to spend much on general introductions into the "Technology of Water," "Crushing and Grinding Machinery," "The Screening and Grading of Materials," and "Organisation and Production." All these books are small volumes mostly of less than 150 pages.

Mr. Pollitt is a little general in the technology of water. We only notice two diagrams in his volume; he dispenses altogether with literature references, and in connection with the only two names mentioned—certainly the only two in the index—Pasteur and Bergefeld, he goes rather out of his way in his critical comparison; we have not found any other critical remarks. Mr. Seymour gives a good deal more information, in text and illustration, on crushing and grinding machinery, but he does not trouble about authorities either. The same applies also to Mr. Lister writing on the screening and grading of materials; enquiries may be addressed to firms, but when authorities are quoted, one would like to know where the statements are taken from. The subject of the organisation of production has only recently received the attention it deserves. Mr. Curtis has made a creditable attempt to outline the problems, and the pages in his volume rather indicate the need of further thought.

Detailed criticism, especially as regards omissions, may easily become unfair when applied to general introductory books. All these volumes of the Technical Engineering Library series have their good points, and they are well printed and bound in cloth. It is difficult to say to what class of readers they are meant to appeal, if not to students, who have frequently to consider carefully what they can afford. There is no prospectus on which one might comment.

THE FIEUX CLUTCH FOR LOCOMOTIVES.

THE extension to railways of engines and gear primarily designed for road transport necessitates the use of a clutch which will permit of sufficient slipping to enable the engine to take up the heavy starting load satisfactorily, but which at the same time has a driven element of sufficiently low inertia to enable gear changes to be effected without difficulty.

These conditions are met by the Fieux clutch, which we illustrate in Figs. 1 to 5, above. In this apparatus a special slipping device is incorporated, which is separated from the clutch proper. This device, styled the "connector," has a large bearing surface, and the drive is by friction between the inner surface of a cylindrical casing, or drum, connected to the transmission shaft, and a steel spiral connected to the engine shaft. The spiral is subject both to the differential action of centrifugal force, which tends to make it grip the drum, and to the engine torque, which has the opposite tendency. The apparatus runs in oil and is entirely automatic in action. On starting up, the amount of slipping which takes place depends on the resistance, and as the speed of the train picks up, the slipping decreases. Slipping will cease at a speed corresponding to the maximum torque of the engine, which will be at about 70 per cent. of the normal speed, and after this point the engine can be accelerated without further slip taking place. We illustrate the connector diagrammatically in Fig. 3. The engine shaft A forms one piece with the disc from which the arms B project; and the links D, D′, which terminate in the weights E, E′, are pivoted on these arms. A loose boss G carries a lever F, to which the links I, I′ are pivoted. These links terminate in weights J, J′, which are in turn pivoted on pins projecting from the weights E, E′. The transmission shaft K is in one piece with the drum L, containing the spiral. One end of the latter abuts on a projection C, forming part of the disc driven by the engine, and the other abuts on the end of the lever F. The spiral is right or left

handed, according to the direction of rotation of the engine.

To follow out the action we will assume that the engine is just taking up the load. In the first instance, all the elements contained within the drum will revolve with the engine shaft. Centrifugal force acting on the weights E^1, E and J, J^1 tend to cause them to move outwards, and produce component forces which act on the end of the spiral through the link mechanism, resulting in driving friction upon the drum. At any instant, the spiral will be in equilibrium under the action of three forces, consisting of the reaction at each end and the frictional force between the spiral and the drum. The frictional force, or driving effort, will therefore be the difference between the two reactions. The reaction T exerted by the end of the lever F on the spiral, depends solely on the component of the centrifugal forces exerted by the weights. If the frictional force, measured at the outer radius of the spiral, be called F, we have $F = T - t$, so that t, (Fig. 3) may be referred to as the "exciting effort" on the spiral, and will evidently be smaller the higher is the coefficient of friction and the number of turns of the spiral.

The relation between F and t is given by $F = t(e^{\mu\theta} - 1)$, where μ is the coefficient of friction and θ the angle of contact. Actually the exciting effort t is low compared with the other forces, so that for an equal torque transmitted, comparatively large variations of t, due to unavoidable variations in the coefficient of friction between the surfaces, can take place without any great change in the value of T, that is, of the speed at which the connector transmits the torque without slipping. In the diagram, Fig. 4, ABC is the engine torque curve on full throttle, and ADE the torque curve on reduced throttle. OBM represents the torque transmitted through the connector. On full throttle, slipping will occur until the point B is reached, the area KBL representing the work absorbed in friction between the coil and the drum. On reduced throttle, slipping will cease at D, and the work absorbed in friction is represented by the area KDS. The curve QP represents part of the torque curve of a more powerful engine, and shows how the apparatus automatically adapts itself to the latter. It will be observed that, on starting, the engine being under no load immediately runs up to the speed OF, and the train gradually picks up until the speed of the transmission shaft becomes equal to that of the engine. At higher speeds the two rotate together. In the event of an overload occurring, the speed of the engine will again fall to OF, when slipping will occur, the torque being maintained at the value FB. It is thus impossible to pull up the engine on an overload.

The actual construction of the connector is shown in Figs. 1, 2 and 5, Fig. 5 also showing the construction of the clutch proper. In this figure the lettering corresponds to that in Fig. 3. The engine shaft A is bolted to the flywheel, the snout K forming part of the transmission drum L. This is coupled to the transmission shaft N through a flexible coupling of the multi-steel plate type, as shown. The coil is shown at M, while J and E are the weights, which are pivoted respectively on the loose boss F and on the pins projecting from the flywheel. Fig. 1 shows the general appearance of the connector assembled but with the cover removed, and Fig. 2 shows the actual arrangement of the weights, of which it will be seen that there are six of each type.

The clutch proper, shown in section in Fig. 5, is of the single-plate type, the driven element Y being of small inertia. This plate slides on the primary shaft Z of the gear-box, and is gripped between a fixed clutch plate O, keyed to the connecting shaft N, and a moveable plate P subject to the action of Belleville springs. Declutching is effected by the sliding piece shown, which incorporates a taper cone operating the separating pins through the medium of small levers on which the cone rollers are mounted.

THE INSTITUTION OF MINING ENGINEERS.

A GENERAL meeting of the members of the Institution of Mining Engineers was opened at Cardiff on Tuesday morning last, when the Rt. Hon. The Lord Mayor of Cardiff, Alderman W. H. Pethybridge, J.P., on behalf of the City, and Mr. H. Spence Thomas, President of the South Wales Institute of Engineers, welcomed the visitors in the Lecture Theatre of the South Wales Institute in Park Place. The afternoon of Tuesday and the whole of Wednesday and Thursday were devoted to visits to works and places of interest in the vicinity.

After the opening of the meeting on Tuesday morning, the Institute Medal was presented to Sir William Galloway, D.Sc. Several papers were then read and submitted for discussion, the first to be dealt with being one of which the author was Sir John Cadman, K.C.M.G., D.Sc., entitled "Petroleum Refining in South Wales." Before proceeding to describe the refinery of the Anglo-Persian Oil Company, at Llandarcy, Sir John gave a short review of the Persian Oil Field, in which the British Government obtained a controlling interest in 1912, thus securing vast resources of oil for all her industrial and national requirements. The development of the oil industry was largely handicapped owing to the war, but the progress that had been made could be judged by the increase in output from 234,000 tons in the year 1913–1914, to approximately 5,000,000 tons annually at the present time. The rapid development in the use of oil was referred to, and the view expressed that oil was not a rival of coal, but rather an ally and associate. The author looked forward to the time when they would be largely interchangeable, though petroleum would always maintain a premier place in certain applications for which it was especially suited. Persian crude oil is a mobile liquid, brown in colour with a green fluorescence, and its mean specific gravity is 0·837. The oil is chemically a "mixed base" crude, predominantly paraffinoid with only about 1 per cent. of asphalt. The oil from the Persian fields is received at Swansea and discharged into shore tanks at a rate of 900 tons per hour; from these the oil is pumped to the tank farm situated for safety at a distance from the refinery. Thence it is drawn to the refinery and given a preliminary distillation, the oil passing through a nest of eight boilers similar to Lancashire boilers, and being heated by a steam jet. This helps to carry over the products which are then passed through condensers, washed, and refined.

The once-run distillate (O.R.D.) contains all the gasoline, and some of the kerosene, while 64 per cent. residue is of the appropriate flash point and viscosity for use as fuel oil, the specific gravity being in the neighbourhood of 0·897 with a sulphur content of about 1·33 per cent., and a flash point of over 175 deg. F., thus conforming with the Admiralty Specification. Its water and adventitious matter content, is of the order of 0·1 per cent., and hard asphalt averages 1·5 per cent.; the low asphalt, sulphur content, and high calorific value, make this oil a very valuable fuel. The sulphur compound contents of the 36 per cent. O.R.D. are removed by the hypochlorite process, consisting of a first wash with a 10 per cent. solution of caustic soda. This removes the hydrogen sulphide, sulphur dioxide, and organic sulphur compounds of an acidic nature. The oil is then treated with sodium, or calcium hypochlorite; the latter is now used at Llandarcy. After this process the oil is put into a washer consisting of a cylindrical tank of 20 ft. diameter by 20 ft. deep, the mixture being kept in motion by pipes connected from the bottom of the tank to centrifugal pumps, the return pipe leading to sprays at the top of the tank. These washers are fitted with doors in the roof that can open freely in case of explosion. After this washing, the oil is drawn off for redistillation into petrol (B.P.) and kerosene. For the decolourising, the oil is passed through a filter of bauxite previously broken and calcined in cement kilns to 600 deg. C., the material being used again and again, though a small percentage of fresh bauxite ore is added to replace losses.

That portion of the 64 per cent. residue from the O.R.D. stills, which is not destined for use as fuel oil, is further reduced in the residue bench which consists of fire-heated stills. The first product obtained is heavy kerosene which may be used to supplement that previously obtained, the fraction amounting to 25 per cent. of the fuel oil, its specific gravity being 0·828, and its flash point 120 deg. F. The next 12 per cent. obtained from the fuel oil, is the gas oil fraction with specific gravity 0·850 and flash point 170 deg.–200 deg. F. The residue containing lubricating oil, wax, and pitch, is further distilled in the pitch stills, the pitch being run off into barrels or into pitch ponds, and the oil containing the wax is pumped, at a pressure of 150 lb. per square inch, through coolers into filter presses where the oil percolates through the cloths, while the wax is retained, the yield of wax being about 6·2 per cent.

This paper was followed by one dealing with "The Maximum Efficiency of Heat Engines, and the Future of Coal and Steam as Motive Agents," by Dr. J. S. Haldane, F.R.S. In it the author dealt with the fundamental theory of Carnot, put forward in 1824, and further developed by Kelvin in 1847, and proceeded to argue at length that it was wrongly based. In dealing with heat as a means of generating power, the steam and gas engine plants were compared from the point of view of heat waste. The author considered that the steam engine would, in the future, become far more widely available and would displace the internal-combustion engine in many of its present uses, while coal, being a cheaper source of heat, would largely displace oil as a fuel for engines, and would find many new uses as a primary source of power, particularly when electrical distribution of this power was further developed.

A third paper, a memorandum by a special committee of mining engineers, dealt with "The Shutting-off of Gob Fires in Gassy Seams." This operation is only resorted to when all other means, such as digging out or packing off, have failed, and is always attended with considerable risk of explosion until such time as the gas percentage in the voids exceeds that at which no further danger may be feared. The risk in a mine where a fire exists is not only confined to the fear of a gas explosion, but also to a subsequent coal-dust explosion which might wreck considerable parts, or even the whole of the roadways of a pit, and cause serious loss of life if men were present. Such coal-dust explosions have repeatedly occurred in the past. Means were described in the report of minimising the danger of a gas explosion extending to a coal-dust explosion, and the report also deals with the precautions to be taken when a district is to be closed off in order to ensure that no after air leakage shall take place, as it is essential, if the sealing is to be effective, that no air shall leak into the area sealed off.

A further paper, prepared jointly by Mr. J. Ivon Graham, M.A., M.Sc., and Mr. T. D. Jones, Ph.D., M.Sc., of the Mining Research Laboratory, Birmingham University, dealt with "Spontaneous Combustion in the South Wales Coalfield." Mr. Graham had taken part in previous investigations in Yorkshire, at the Doncaster Coal Owners' Laboratory, and the results of these tests were published in the Transactions of the Institution for 1923-24. The occurrence of heatings and fires arising from spontaneous combustion due to oxidation was, fortunately, not common in the South Wales Coalfield, and fires due to this cause, according to a statement made by the authors, had only been reported from 13 collieries. This comparative immunity lent special interest to the investigations made, as the contributory causes could be more easily identified. The seams considered most liable to fire were the Victoria and Swansea 5 ft., the 9-ft. seams, and the South Fawr seams. A review of the factors which appear to have an important influence on the occurrence of fires, pointed to the fact that, in general, fires occurred where, through geological disturbance, the seam of coal had been found to be considerably thicker than the average, and with this thickening, the coal was found to be more fragile in character. In practice it is not possible to remove the whole of this coal, a large portion having to be left in the roof. The seams concerned appeared to be subject to a considerable amount of crush, and the wastes, in the case of longwall working of the 9-ft. seam, were only partly filled owing to the scarcity of packing material. A considerable amount of timber in the form of chocks would appear to be used to compensate for this scarcity, as it was not possible to use the coal got from ripping for stowing and roadside packs. The conditions thus created were favourable for air leakage through the gob, and this in turn was a fruitful source of fire where pyrites was present. As in other coalfields, the first sign of fire was a peculiar odour on the return side of the part affected. In one case, this was traced to two stalls abandoned some months previously on account of water, and where a great deal of coal had fallen from the roof and face. The ventilation was increased, but it was then too late and only served to fan the trouble; finally, the district had to be sealed off. A noteworthy point in connection with the heatings was the short time that usually elapsed between the arousing of suspicion and the finding of the actual fire. In order to ascertain more definitely the part played by the different bands comprising the seam, complete sections were taken from the various seams and examined from the point of view of friability and also oxidisation. The samples were ground, sieve tested, and tabulated. From the results of the oxidation experiments it is evident that the South Wales coals, in general, absorb very little oxygen at temperatures below 100 deg. C., compared with the higher oxygen content coals from South Staffordshire and South Yorkshire, and this, no doubt, accounts very largely for the comparative immunity of the district from fires.

In general, it may be stated that spontaneous combustion in the South Wales coalfield appears to depend more upon the physical factors involved by the thickness of the seam, the method of working, and the friable nature of the coal, than upon the presence of any portion of the seam which is readily oxidisable at ordinary pit or goaf temperature. In cases where spontaneous combustion is met with in seams of more or less normal thickness, the initiating cause appears to be the oxidation of pyrites present in a finely disseminated form. Where fires have occurred in abnormally thick coal, though the broken coal may have been partly responsible, there is no doubt that a local accumulation of pyritic matter has very largely accelerated the oxidation of the coal.

A final paper was read by Mr. J. H. Cockburn, O.B.E., explanatory of the Mines (Working Facilities and Support) Act, 1923, Part I. The new Act gives effect to views set forth in reports by various Government Commissions, and particularly by the 1919 Committee which was presided over by Sir Leslie Scott,

THE ERECTION OF THE TEMPORARY WATERLOO BRIDGE.

(*For Description, see Page* 763.)

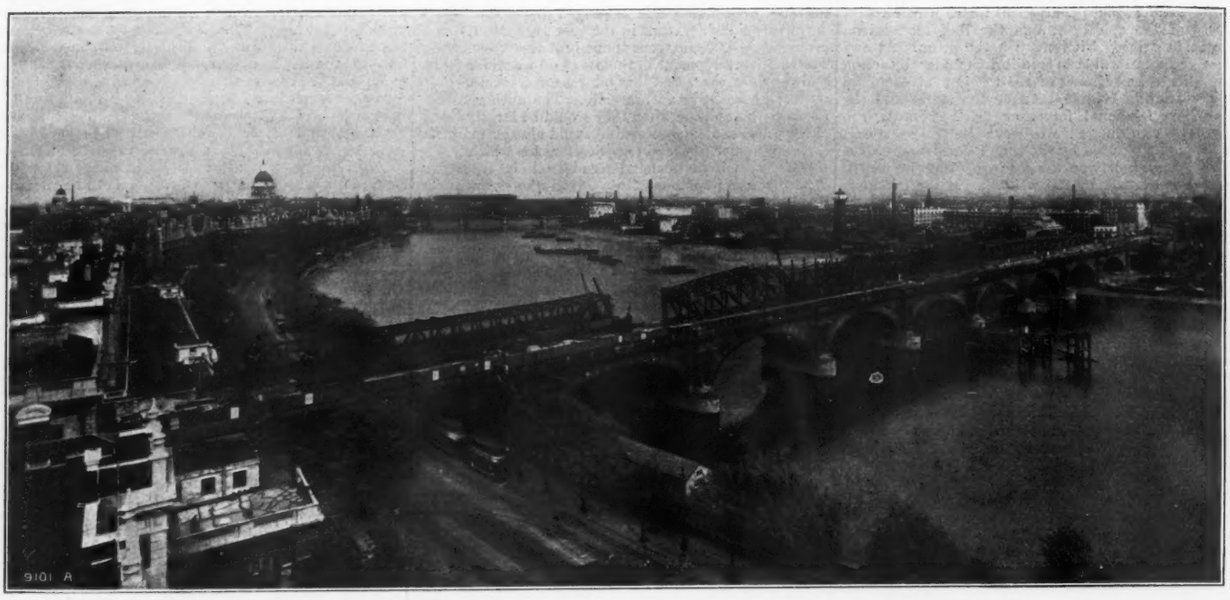


FIG. 1. GENERAL VIEW SHOWING THE CENTRAL SPAN OF THE TEMPORARY BRIDGE WHERE IT WAS ERECTED.

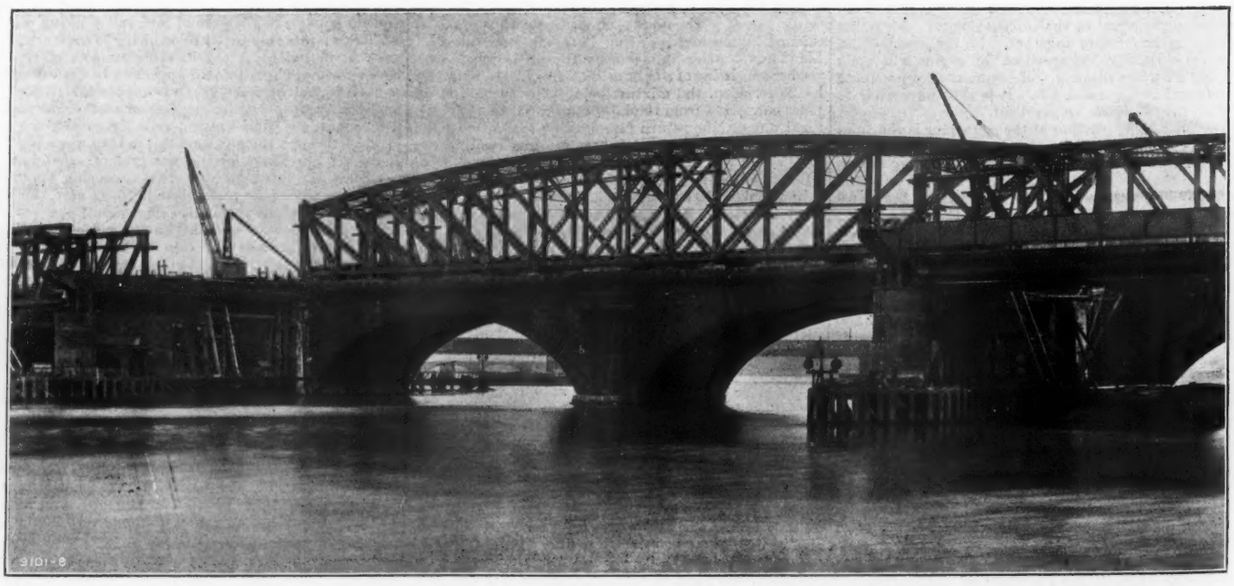


FIG. 2. CENTRAL SPAN OF TEMPORARY BRIDGE READY FOR LAUNCHING.

K.C., M.P., which comprised among its members, Mr. W. Forster Brown, Sir Adam Nimmo, Sir T. R. Ratcliffe-Ellis, and the late Mr. C. E. Rhodes. As a member of the special committee of the Mining Association, the author had some share in the drafting of the Act, and was thus in an exceptionally good position to explain the meaning and intended scope of the clauses which the Act covers, and the intended relief that may be expected as a result of appeal to the Tribunal in cases of hardship. The national interest is the key phrase of the Act, and governs and elucidates the principles by which it will be interpreted and administered. It was considered advisable that special powers should be applicable to the mining industry, to which some of the rights pertaining to private property should be subordinate, and wherever the best development of the nation's mineral resources was impeded by the rights of private property owners, an application might be made to the sanctioning authority to obtain compulsory powers to deal with the situation on fair terms to the owner.

In protection of existing lessees, it is considered that the words "national interest" are not to be applied so as to force development in advance of the ordinary progress of the working of minerals. So long as the mines of a provident company are being fairly worked, it is right and reasonable that they should be able to reckon on long continuance of their sources of supply, especially as the sinking of modern shafts to great depths entails a large expenditure and heavy outlay for years before any return is obtained for the initiative and enterprise of the mining company. On the other hand, it is not right that any unsuccessful concerns should be allowed to prolong their existence by taking away any of the reserves of more vigorous and enterprising neighbours. The Act does not require that a mining company should be put under an obligation to work against its will, there being no necessity for this in the national interest, as the economic law of demand suffices, with its incentive for commercial profit; but a mine owner must, of course, submit to any order made directing him to leave minerals unworked for support. The amount of coal left for support, with the greater depths, must necessarily be considerable to be effective, and can be provided for years in advance in the lay-out and schemes for the winning of the coal, but under the above Act, a small and irritating difficulty

THE TEMPORARY WATERLOO BRIDGE.

FIG. 3. VIEW SHOWING GIRDERS BETWEEN THE OLD AND TEMPORARY BRIDGES.

FIG. 4. CENTRAL SPAN JUST CLEAR OF THE OLD BRIDGE.

will be swept away by the ability of the mining company to do away with needless restrictions and onerous covenants, such as the leaving of barriers between adjoining properties merely for marking the boundary of an estate and for minimising the risk of trespass beyond. It is good mining practice to keep the face moving, the weight being then thrown well back on to the goaf or gob, and the needlessly heavy expense of fresh heading work being avoided; moreover, the barriers provided for are useless if worked at either side, and the coal is simply crushed and lost, and may even be a source of danger to the mine and miners, if spontaneous combustion should set in.

Among the useless restrictions quoted were those in which a deed stipulates that a pillar of coal shall be left unworked for the support of the surface only, or for relatively unimportant buildings, or where there is an obligation to leave a larger pillar than is reasonably necessary. The tribunal can grant a right to work such a pillar of coal, subject to reasonable compensation for the value of the buildings or works as compared with the value of the minerals. A further instance is where the lease contains defective provisions in respect of allowance for bad, thin, and unmarketable coal, and the lessor insists on payment of full royalty, so that the lessee cannot work the coal without loss, with the consequence that danger exists of inferior coal being left permanently unworked. The tribunal can direct that a fair and reasonable allowance shall be made from the normal royalty. That the cases of dispute and friction are not confined to lessee and lessor alone is brought to notice in the action of highway authorities in connection with road subsidence, and a ruling has been obtained from the House of Lords that after minerals are worked a mining company need not raise a subsided highway to its pre-existing level and are only liable for the cost of making it equally passable and commodious.

Mr. Cockburn proceeded to show the remedies that may be obtained from the Act in such cases. Long discussions on the paper have followed its reading at Doncaster, Manchester, Newcastle and Leeds, and in every case Mr. Cockburn has received the thanks of the mining community for the interesting and instructive legal view and explanation of the Act put forward. The effects of the working of the Act will be watched with interest by all concerned in the mining industry and a tendency towards standardisation of future mining leases, varying only in details according to local custom and usage, may be expected.

THE ERECTION OF THE TEMPORARY WATERLOO BRIDGE.

IN view of the decision to demolish the old Waterloo Bridge over the Thames and to replace it by a structure more suited to the requirements of both the road and river traffic, it was necessary to erect a temporary bridge which would meet the requirements of the traffic during the time of rebuilding. The well-known bridge constructors, Sir William Arrol and Co., Limited, of Glasgow, were entrusted with the contract for the erection of this temporary structure and they have just completed, as we go to press, the main part of the work. The new bridge was erected in sections on the old bridge and moved out into place on the new cylindrical piers. In this work little difficulty was experienced until the centre span had to be put into position and this was successfully accomplished during the current week. The work consisted in launching the central span, the operation being shown in progress in the illustrations on this and the opposite pages, which were prepared from photographs by Mr. E. Milton, North Finchley. This span is 277 ft. 4 in. in length, is 27 ft. 6 in. between the booms and has a height of 24 ft. at the end posts and 35 ft. at the centre. The weight of this part of the bridge being 500 tons, it is, we understand, the heaviest single element of a bridge which has been launched sideways into place on to the piers.

The procedure adopted was to run out heavy girders from the old structure to the new and lay rails on these for the accommodation of the bogies, which were put under the two ends of the span before the removal of the supports on which it was erected. Winches were installed at both ends of the new span and from these the ropes were taken by a snatch block to pulley blocks of 20 tons capacity, with four sheaves at one end and five on the other. From these blocks the launching ropes were carried over the gap between the old and the new bridges and passed over pulleys mounted on the far side of the new piers. All the preliminary operations were concluded on Monday night, June 15, and at 4.30 a.m. on Tuesday the actual work was started. By continued operation of the winches, the ropes were first made taut and the structure was then gradually drawn out into place. The distance that had to be traversed was 88 ft. In the first part of the work a rate of about 2 in. a minute was used, but when it was seen that everything was proceeding satisfactorily, the speed of working was increased, and the greater part of the work was actually done at a rate of 6 in. per minute. Markings at every 6-in. distance along the rail girders were used for guidance in the control of the operations of the men at the winches, and signalling by flags was adopted to ensure that the movements were made uniformly at each end. A special screw device was fastened to the tracks to check the travel during the whole time of launching. Observations were made continuously and the work proceeded until 9.30 a.m., when the span had been got completely clear of the old bridge. On the resumption of the work at the winches, continued progress at a uniform rate for each end was reported and the span was in proper location, but still on the bogies, by a few minutes after mid-day. No hitch whatever occurred during the whole of the work.

On Wednesday, the preliminary work for the lowering of the new span into place was undertaken, and the actual work involved in the gradual lowering through a distance of 12 ft. was carried out yesterday (Thursday). The first part of this consisted in removing the bogies. For this purpose four high-capacity hydraulic jacks were mounted under the structure at both sides of each end of the span. By the lifting of the jacks the bogies were freed from load and were then drawn out and were replaced by the four fixed and expansion bearings. The span was then lowered by

the jacks until the bearings rested on their temporary supports when the jacks were reset to perform another stage in the process. Gradual movements of the jacks were effected so that, section by section, the supporting structures could be removed and the work was performed in a total of 20 stages for the full descent of 12 ft. In each operation, the bearings were brought down 7½ inches. The load was then taken on the jacks and the bearing supports reduced again another 7½ in. Further lowering was carried out and, eventually, the structure was brought down into its final location. Throughout the whole of this work the utmost care was necessary to avoid accident, and great credit must be given to those who were responsible for its successful achievement. Not only are the builders to be congratulated on the expedition shown by them in erecting the bridge, but also for the skill shown in dealing with the launch of a heavy central span sideways into place. Sir John Hunter, the managing director of the constructors, Sir William Arrol and Co., Limited, and Mr. Adam Hunter, the chief engineer of the same organisation, undertook the direction of the work, while Mr. G. W. Humphreys, chief engineer of the London County Council, his chief assistant, Mr. W. C. Copperthwaite, and Mr. F. S. Habell, the resident engineer, superintended it on behalf of the County Council.

Now that the new bridge is in place, all that remains to be done is to prepare the road on it and this, it is anticipated, will be completed by the end of July, when the original Waterloo Bridge, built by John Rennie, will be relieved of its load, preparatory to its demolition and replacement by a much wider bridge on secure foundations and with fewer spans. Once this has been done one source of road traffic congestion in London will be removed and the river will be freed from the troubles associated with a bridge of several narrow spans crossing it where there is a bend in the course.

DIVERSION TUNNEL GATES FOR THE ARAPUNI HYDRO-ELECTRIC POWER SUPPLY.

THE control gates which we illustrate in Figs. 1 to 10, on this and the opposite pages, are of particular interest, owing to their large size and to the high head, amounting to some 158 ft., under which they operate. The water pressure on each gate is about 1,200 tons, and it is thus probable that they are the most heavily-loaded free-roller sluice gates yet constructed. The gates have been designed and manufactured by Messrs. Glenfield and Kennedy, Limited, of Kilmarnock, to the order of Sir W. G. Armstrong, Whitworth and Co., Limited, who are the contractors for the Arapuni hydro-electric power scheme, New Zealand. The latter includes the construction of a dam across the Waikato River, which will create an artificial lake about 20 miles long. The ultimate installation will consist of eight units, each of 25,000 b.h.p. maximum capacity, and 21,000 b.h.p. normal load capacity. Under the present contract, the penstock tunnels and valves, turbines and generators for only three units are to be installed, the power-house building being constructed of sufficient length to accommodate four units. The generators will supply power at 11,000 volts, the greater part of the energy being stepped up to 110,000 volts for long distance overhead transmission. Much of the power generated will be delivered through the transmission line at the latter voltage to Auckland City, a distance of approximately 100 miles from Arapuni.

The location of the diversion tunnel in which the gates operate is shown in the key plan, Fig. 1 and in Fig. 2, at the site of the headworks on the Waikato River. This plan also shows the position of the main dam, and of the temporary dams and diversion tunnel. The purpose of the latter is to keep the site of the main dam free from the river flow. On the completion of the work, the tunnel will be available for controlling floods, and for regulating the storage supply, as well as for emptying the reservoir, if found necessary. It will be seen in the plan that there are two gates placed in a bifurcated chamber near the upper entrance. The bifurcation of the tunnel is shown in Figs. 6 to 8, from which it will be seen that special regard has been paid to the hydraulic conditions of flow, a gradual convergence taking place to the normal section of the tunnel. Either expansion or contraction of the stream is carefully avoided in order to eliminate any risk of erosion due to turbulence. A vertical shaft 36 ft. 10 in. wide, by 6 ft. broad, extends from the gate chambers to the ground level, at which the operating gear is placed, as shown in Fig. 2 and in Figs. 3 to 5. The total depth of this shaft is 181 ft. Each of the sluice gates closes a clear opening 21 ft. 9 in. high by 11 ft. 9 in. wide, and as mentioned, is designed to withstand a head of 158 ft. and a total pressure load of 1,200 tons.

Turning now to the actual construction of the gates and sluice frames, shown in Figs. 3 to 5, and 9 and 10, each gate is built up of a series of horizontal rolled steel

THE ARAPUNI HYDRO-ELECTRIC POWER SUPPLY.

Fig. 1.

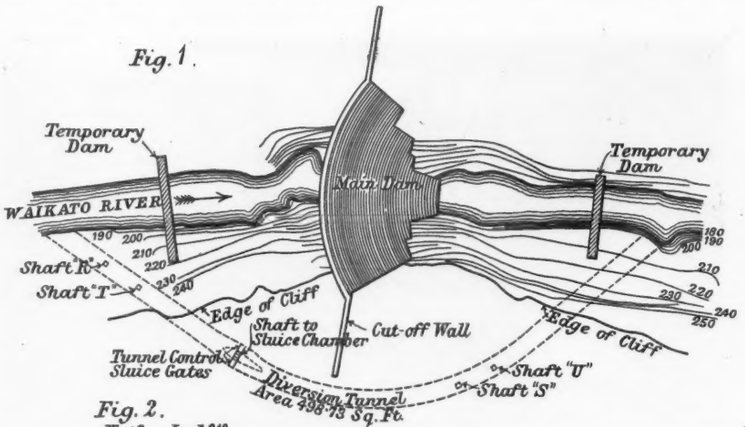


Fig. 2.

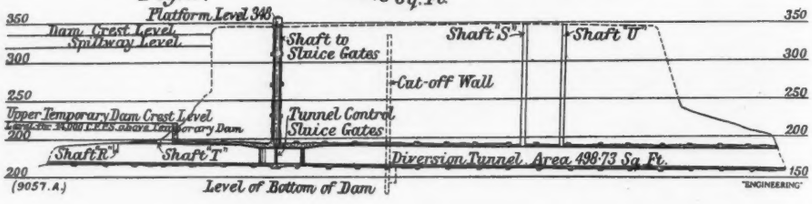


Fig. 3.

Fig. 4.

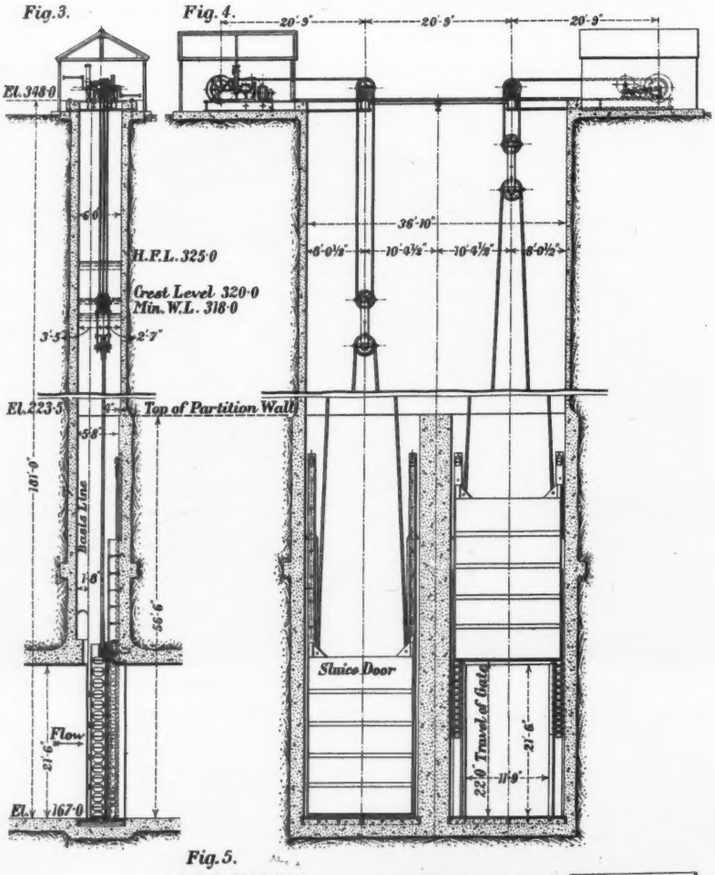
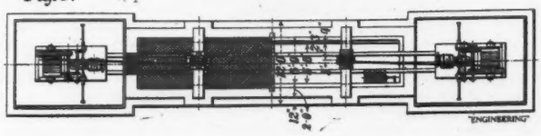
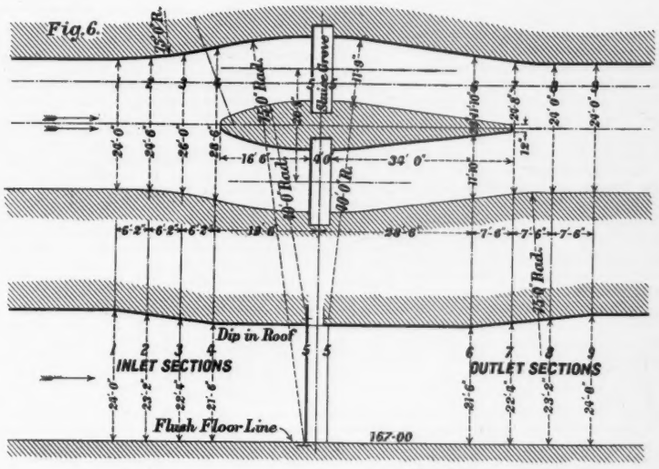
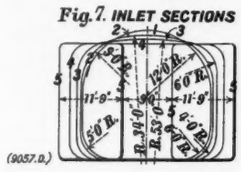


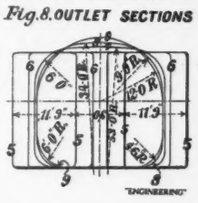
Fig. 5.

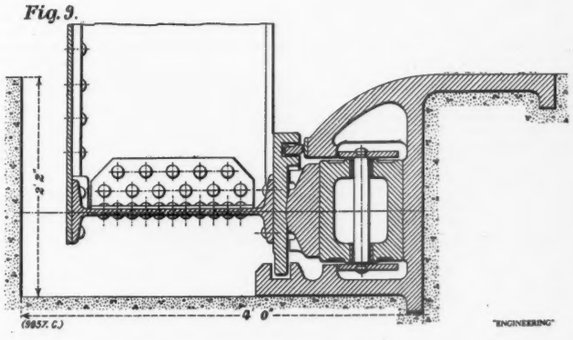


DIVERSION GATES FOR THE ARAPUNI HYDRO-ELECTRIC POWER SCHEME.









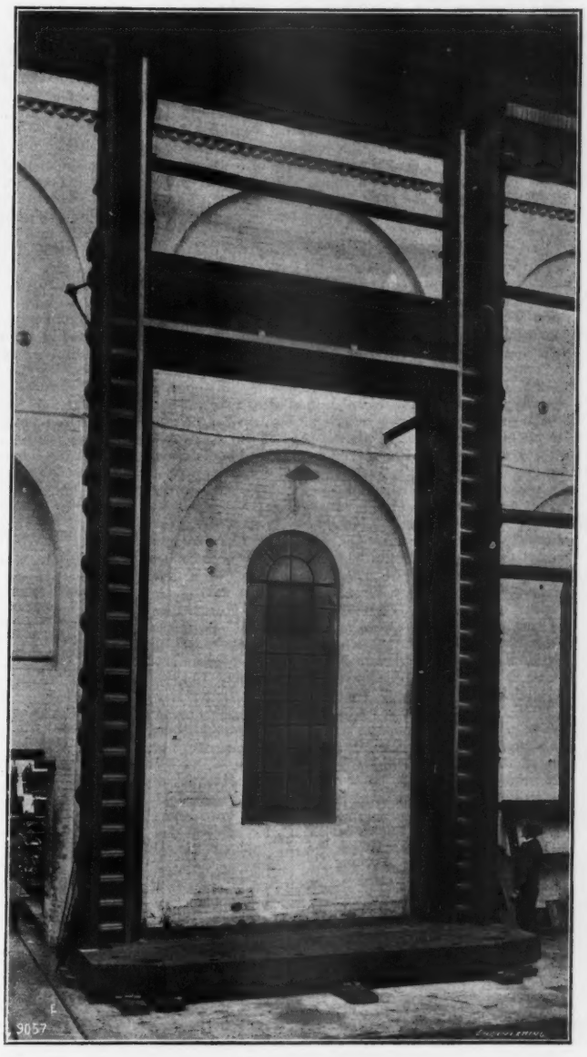


FIG. 10.

joists 24 in. deep, securely riveted to vertical end posts of similar section, and to skin plating attached to the upstream side. The gates are supported by a double vertical train of anti-friction rollers, with self-aligning or articulated roller paths of the firm's special construction, interposed between the gate endposts and each train of rollers. This arrangement ensures equal bearing loads over the whole width of each individual roller, and is shown in Fig. 9. When the gates are lifted, the free roller trains travel only half the movement of the gate, and, in consequence, rollers are left exposed underneath, and these, in the normal type of free roller gate, are subject to the action of the water flowing at high velocity past the gate groove. In the gates shown, these exposed rollers are protected against this action by being securely housed within the cast-iron gate groove, as shown in Fig. 10. This arrangement has been Messrs. Glenfield and Kennedy's standard practice for some time in connection with sluices for high-velocity discharge and silt-laden waters. The free rollers are made of specially hard cast-iron, and are machined to a tolerance of 0·002 in. to ensure that each roller carries its true proportion of the load. The trains of rollers are suspended in the bight of a galvanised steel wire rope, one end of which is attached to the gate and the other to the top of the cast-iron groove extension, thus allowing unrestricted rolling motion to the rollers during the operation of the gate.

The gate is made watertight when in the closed position by an arrangement of self-adjusting gunmetal staunching bars, which have a flexible attachment with the gate and make contact with corresponding gunmetal faces secured to the cast-iron grooves. One of these bars can be seen in section in Fig. 9, and the gunmetal faces on the sluice frame can be seen in Fig. 10. The bottom joint of the gate is sealed by contact between a wide machined edge attached to the bottom of the gate, and a high-carbon removable steel face which is recessed into the cast-iron sill. When the gate is partially raised and a free discharge is taking place, a velocity of 90 ft. per second is reached, and the erosion which would otherwise occur due to this high velocity is prevented by the removable steel face of the sill referred to. The sluice frames, one of which is shown in Fig. 10, are of cast-iron throughout, and are of very heavy construction, with an exceptionally wide and deep sill. The weight of one of these frames is just under 30 tons, the gates themselves each weighing 22 tons.

The lifting gear, which is shown in Figs. 3 to 5, is electrically operated. It is fitted with emergency hand gear and is connected to the gate suspension cables through treble wire rope blocks. The whole gear is designed for a lift of 40 tons, so as to give an ample margin over the weight of the gate added to the frictional resistances. The gate suspension cables are of galvanised wire rope, $1\frac{7}{8}$ in. diameter, and are slung over a compensating pulley which is attached to the rope blocks by steel side plates, as shown in Fig. 4. The hoisting gears have machine-cut teeth throughout, the first motion being by worm reduction followed by spur reduction. These motions work in dust-proof casings and run in oil. The motors are fitted with solenoid brakes and are controlled by oil-brake switches for local operation. Limit switches are also fitted to prevent overrunning of the gear at each end of the gate travel. Indicators are fitted in conjunction with this gear to show the position of the gate throughout its travel. The speed of raising or lowering, with electric power, is about 15 in. per minute.

PERSONAL.—We are informed that Messrs. Sleeper and Hartley, Inc., of Worcester, Mass., U.S.A., specialists in high-speed automatic wire-coiling machinery, have taken up the manufacture of the spring- and wire-coiling machines formerly produced by the Garvin Machine Company of New York.—The Export Credits Section of the Department of Overseas Trade is removing, on June 29, from 73, Basinghall-street, E.C.2, to 30 and 31, King-street, Cheapside, E.C.2.

CONTRACTS.—The new vessels Alaunia and Carinthia, of the Cunard Steamship Company, Limited, which are shortly to run their trials, are each to be equipped with a Sperry gyro master compass, repeaters, and course recorder made by the Sperry Gyroscope Company, Limited, 15, Victoria-street, London, S.W. 1. An additional repeater is to be installed in the wireless room of each ship, to operate in conjunction with the wireless direction finder.—Messrs. Joseph Kaye and Sons, Limited, Lock Works, Leeds, have secured a contract from the Admiralty for a large quantity of their improved force-feed type of serrated-steel seamless oil feeders.—Messrs. John Booth and Sons, engineers, of Hulton Steelworks, Bolton, have received an order, placed by the Manchester Ship Canal Company, for 568 steel sliding fireproof warehouse doors.

LETTERS TO THE EDITOR.

BRITISH AND AMERICAN PRACTICE IN STRUCTURAL STEEL DESIGN.

TO THE EDITOR OF ENGINEERING.

SIR,—The interesting article by Mr. Robins Fleming, of New York City, in your issue of June 5 makes references to my *Theory of Structures*. After saying that lapses in British and American text-books on this subject are rare, he apparently proceeds to instance one from my book, viz., the calculation of a secondary stress in lattice bracing of a column due to shortening of the main ribs and apart from the stress due to any lateral deflection. He suggests that such stresses cannot exist.

To simplify matters, it is only necessary, when lateral deflection is eliminated, to consider the case of an ideal axial compressive load. Mr. Fleming's subsequent argument makes it evident that everything depends upon the question of whether the column ribs are kept the same distance apart or move freely in a lateral direction. If they move laterally just the right amount to compensate for the shortening of the vertical projection of the bracing (on a vertical column), and so leave the diagonal bracing unstrained, it is agreed that there will be no stress in the bracing. But do they? A simple model or a mental picture thereof will make the matter clear. Stout ribs placed a considerable distance apart and laced by relatively slender bars are not free to move laterally to a sufficient extent to produce no effect on the bars, and this is particularly obvious at the ends of the column. Actually, no doubt, conditions will vary between the extremes of complete freedom and complete constraint. But I should like to be allowed to quote the words with which the calculation of this secondary stress is introduced in *Theory of Structures*, adding here certain italics: "Stresses *may* arise due to the strain of the column. Thus, if tie column is shortened *and the width remains unchanged*, the diagonal lattice bars are also shortened, introducing a secondary stress." In view of these words, I should like to suggest that the "lapse" is not mine.

The designer must, of course, in this as in many cases, use his judgment as to how far the conditions of the problem are satisfied in any particular case, but he should not be blind to the possibilities. Since Mr. Fleming proceeds later to quote an example of British plate-girder practice from what he calls "an excellent British textbook," unnamed but easily identifiable as my *Theory of Structures*, I feel sure his omission to state in any way the qualification quoted above is only an accidental "lapse." But the qualification is vital. Many stress computations in structural engineering must be made for two limits when the imperfectly known conditions are actually intermediate, but it is certainly unwise to ignore altogether the upper limit, which in some cases may certainly be closely approached.

Yours faithfully,

ARTHUR MORLEY.

9, Highfield-road, Purley, Surrey, June 12, 1925.

PASSENGER FERRY STEAMER FOR LAGOS.—The twin-screw passenger ferry-steamer "Kathleen," built by Messrs. John I. Thornycroft and Co., Limited, to the order of the Crown Agents for the Colonies, under the supervision of Messrs. Wells and Kemp, consulting naval architects and marine engineers, St. Stephen's House, Westminster, completed her trials and sailed for Lagos on May 21. Details as to the construction and equipment of the vessel were given in our issue of April 17, page 481.

LAUNCH OF THE S.S. "SANDLAND."—Built by Messrs. Swan, Hunter, and Wigham Richardson, Limited, Wallsend-on-Tyne, for Messrs. Terry and Robertson, Toronto, the "Sandland," a steel single-deck screw-steamer, with hopper for carrying sand and gravel, was launched at Wallsend on June 6. The vessel, which is 205 ft. long, 42 ft. 6 in. breadth moulded, and 18 ft. 6 in. depth moulded at the side of the main deck, is being built under special survey to plans approved by Lloyd's Register for their 100 A1, "Sand Pump Hopper—Lakes Ontario, Erie, and Detroit River." The "Sandland" will carry about 1,750 tons on a reasonable draft and two centrifugal pumps will be installed at the forward end. The vessel has a raised quarter deck and forecastle, a Texas house on the top of the forecastle with navigating bridge and wheel-house above. A special cabin for the owners is fitted in the forecastle. The engines and boilers, which are being built by Messrs. MacColl and Pollock, Limited, Sunderland, will be placed at the after end of the ship: the former are of the inverted marine type with three cranks; the boilers are two in number and are of the cylindrical single-ended variety. A cargo hold is placed between the boiler-room and after end of the hopper. Water ballast will be carried under the engines and boilers, in the forward and aft peaks, in a deep tank at the forward end, and at the sides of and underneath the hopper. Steam heating and electric lighting is provided in the quarters of officers and crew.

ENGINEERING TRAINING AND EDUCATION.

The Crystal Palace School of Practical Engineering.—Founded in 1872, and approved by the Council of the Institution of Civil Engineers, the main object of the Crystal Palace School of Engineering is to prepare students for the profession by a system of combined practical and theoretical instruction. The mechanical engineering course, which is comprised in one year of three terms, is designed to convey such instruction as is essential to a student who intends to become a mechanical engineer and is preparatory to the civil engineering course. The latter is intended for students wishing to enter the offices of civil, structural or municipal engineers. Evening classes are also held to enable students to complete their preparation for the Assoc.M.Inst.C.E. examination. Visits are made, from time to time, to various works of interest and debates are held each term, under the presidency of the principal, in order to afford students an opportunity of gaining confidence in public speaking on professional matters. This latter is an interesting and important feature of the curriculum. A brochure prepared by the Advisory Committee of the School's Old Students' Society, and entitled "Notes on the Training Necessary for the Profession of Engineering," has just been issued. Succinct and practical, it is intended for parents and guardians desirous of learning what steps should be taken in the education and training of those wishing to follow the career of an engineer.

BOOKS RECEIVED.

Technische Wirtschaftslehre. Leitfadenzen Einführung des Technikers in die Wirtschaftsarssenschaften. By THEODAR JANSSEN. Leipzig: Wilhelm Engelmann. [Price 16 marks.]

The Design of Railway Location. By CLEMENT C. WILLIAMS. Second edition, revised. New York: John Wiley and Sons, Inc. London: Chapman and Hall, Limited. [Price 20*s.* net.]

Die Wirkung wagerechter Krafte bei eisernen Brucken. By J. KARIG. Berlin: Wilhelm Ernst & Sohn. [Price 3.60 marks.]

United States Geological Survey. Mineral Resources of the United States. I: 19. *Gold, Silver, Copper and Lead in California and Oregon in* 1923, *Mine Report.* By J. M. HILL. I: 20. *Gold, Silver, Copper, Lead and Zinc in Idaho and Washington, in* 1923, *Mine Report.* By C. N. GERRY. I: 21. *Gold, Silver, Copper, Lead and Zinc in* 1923, *Mine Report.* By V. C. HEIKES. I: 22. *Gold, Silver, Copper, Lead and Zinc in Montana in* 1923, *Mine Report.* By C. N. GERRY. I: 23. *Gold, Silver, Copper, Lead and Zinc in Nevada in* 1923, *Mine Report.* By V. C. HEIKES. I: 24. *Gold, Silver, Copper, Lead and Zinc in Arizona in* 1923, *Mine Report.* By V. C. HEIKES. II: 28. *Asbestos in* 1923. By E. SAMPSON. II: 29. *Natural Gas in* 1923. By G. B. RICHARDSON. II: 34. *Coke and By-Products in* 1922. By F. G. TEYON. Washington: Government Printing Office.

United States Geological Survey. Water Supply Paper, No. 541. *Surface Water Supply of the United States,* 1922. Part I. *North Atlantic Slope Drainage Basins.* [Price 25 cents.] Washington: Government Printing Office.

United States Geological Survey. Bulletin No. 755. *Mineral Resources of Alaska. Report on Progress of Investigations in* 1922. By A. H. BROOKS and others. [Price 40 cents.] No. 764. *Phosphate Deposits in the Wind River Mountains, near Lander, Wyoming.* By D. D. CONDIT. [Price 15 cents.]. No. 770. *The Data of Geochemistry.* By F. W. CLARKE. Fifth edition. [Price 1 dol.] Washington: Government Printing Office.

Compressed Air and Its Machinery. By T. H. Plummer, D.Sc. London: Association of Engineering and Shipbuilding Draughtsmen. [Price 10*s.* post free.]

How to Drive a Car. A Complete Guide and Handbook. By the Editor of *The Motor.* Ninth edition. London: Temple Press, Limited. [Price 2*s.* 6*d.* net.]

Practical Astronomy. A Text-Book for Engineering Schools and a Manual of Field Methods. By GEORGE L. HOSMER. Third edition. New York: John Wiley and Sons, Inc. London: Chapman and Hall, Limited. [Price 13*s.* 6*d.* net.]

The Strength of Materials. A Text-book for Engineers and Architects. By EWART S. ANDREWS, B.Sc. Second edition. London: Chapman and Hall, Limited. [Price 13*s.* 6*d.* net.]

An Introduction to Physical Geology, with Special Reference to North America. By WILLIAM J. MILLER. London: Chapman and Hall, Limited. [Price 13*s.* 6*d.* net.]

CLIFDEN WIRELESS STATION.—The famous Marconi wireless station at Clifden in Ireland is to be dismantled and has been sold to Messrs. T. W. Ward, Limited, Sheffield, for that purpose. This station has played a leading part in the development of wireless transmission, and pre-war enthusiasts will remember it as the first wireless station to have regular communication with America, on a wave-length of 7,000 metres. The machinery and equipment has now become obsolete through the advance of wireless science and the increasing use of wireless for commercial purposes.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—The dividing line between improvement and retrogression tends to become more clearly marked. Whereas in tools and certain classes of implements conditions have undergone a definite change for the better, in departments supplying raw and semi-finished materials there is general depression accompanied by signs of the advent of a further setback. Neither pig-iron nor basic steel shows any improvement. Three-quarters of the furnaces producing mild steel are idle, and though conditions as regards acid steel production are not as bad, they continue far from satisfactory. It was believed some time ago that prices of raw and semi-finished materials had touched bottom, but owing to the widespread insufficiency of orders, coupled with the deleterious effect of foreign importations, it has been found necessary to prune quotations still further Some of those now current represent a lower level than has obtained at any period during the past twelve months, embodying reductions ranging from 2*s.* 6*d.* to 10*s.* per ton. Revised prices, per ton, delivered at local works, are as follows:—Hard basic steel billets, 9*l.*, soft basic steel billets 7*l.* 15*s.*, West Coast hematites 4*l.* 15*s.*, East Coast hematites 4*l.*, Lincolnshire No. 3 foundry iron 3*l.* 15*s.*, Lincolnshire forge iron 3*l.* 12*s.* 6*d.*, Derbyshire No. 3 foundry iron 3*l.* 15*s.*, Derbyshire forge iron 3*l.* 12*s.* 6*d.*, bars 13*l.*, sheets 15*l.* Tool steel, which affects such a wide range of productivity, is again suffering from paucity of foreign orders, and plants find difficulty in working economically. The call for mining steel and machinery shows a falling off owing to the continued slump in the coal export trade, though orders are in hand for the equipment of several new enterprises. The most cheerful feature of the position is the revival in edge tools, agricultural tools, and certain engineering requisites—suggesting in the last-named respect that increased activity is anticipated in the general engineering trades. Russian orders are becoming an important factor. File works have experienced a considerable accession of business both on home and export account, and have considerably increased their outputs.

South Yorkshire Coal Trade.—Scarcity of orders has resulted in keener competition for the amount of business in circulation, and though official quotations show no further alteration, prices in several sections display a drooping tendency. Contract inquiries are being made for house coal, but collieries decline to commit themselves far ahead in the absence of more definite pointers. Home consumption of best steams, cobbles and nuts is maintained at a moderate level despite the weakening effect of the shipping slump. There is some inquiry for washed slacks, but very little movement in smalls. Quotations:—Best branch handpicked, 30*s.* to 33*s.*; Barnsley best Silkstone, 26*s.* to 27*s.*; Derbyshire best brights, 23*s.* to 26*s.*; Derbyshire best house, 21*s.* to 23*s.*; Derbyshire best large nuts, 17*s.* 6*d.* to 20*s.*; Derbyshire best small nuts, 12*s.* to 14*s.*; Yorkshire hards, 17*s.* 6*d.* to 21*s.*; Derbyshire hards, 17*s.* 6*d.* to 21*s.*; rough slacks, 10*s.* to 12*s.* 6*d.*; nutty slacks, 8*s.* 6*d.* to 10*s.*; smalls, 3*s.* 6*d.* to 5*s.* 6*d.*

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—The Summer Meeting of the Institution of Heating and Ventilating Engineers will be held in Birmingham on June 22, 23 and 24. On June 22, the Council of the Institution will meet at the Queen's Hotel at 5.30 p.m., and on the following day, at 9.30 a.m., there will be a General Meeting of members, also at the Queen's Hotel. In the afternoon the Bourneville Works of Messrs. Cadbury Bros., Limited, will be visited, members reassembling at the Queen's Hotel in the evening for the banquet. A motor drive through Shakespeare's Country has been arranged for Wednesday, June 24. The offices of the Institution are situated at 38, Victoria-street, London, S.W. 1.

TENDERS.—The Department of Overseas Trade, 35, Old Queen-street, London, S.W.1, announces that the Union of South Africa, Department of Irrigation, invites tenders for the supply of six Fox's trip casing spears; 1,000 ft. each swelled and cressed wrought-iron or mild-steel casing of 5 in., 6 in., 7 in. and 8 in. internal diameter; and, alternatively, 1,000 ft. each swelled (only) wrought-iron or mild-steel casing of 5 in., 6 in., 7 in. and 8 in. internal diameter. Tenders must reach the Chairman of the Union Tender Board, Union Buildings, Pretoria, by 3 p.m. on August 26, 1925. Further particulars may be obtained from the Department of Overseas Trade. It is further announced by the Department that it is the intention of the authorities of the Turkish Government Railways to purchase, by direct negotiation with firms, approximately 1,500 steel tyres of all sizes for locomotives, coaching and wagon stock, as well as standard "screw and safety" couplings of the Continental type. Additional particulars as to the latter may be obtained from the Department.—The Union of South Africa, Department of Irrigation, invites tenders, to be presented not later than September 2, for the supply of seamless steel tubing. Local representation is desirable. In making inquiries from the Department of Overseas Trade, in this connection, reference A.X. 2118 should be quoted.—The Department also announces that the New South Wales Government, Railways and Tramways, are calling for tenders, to be presented by September 9, 1925, for the manufacture, supply, and erection on the rails, provided at the Power House, White Bay, Sydney, of one electric travelling jib crane, together with the maintenance for twelve months. Further particulars may be obtained from the Department of Overseas Trade, quoting reference A.X. 2120.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Business in Cleveland pig-iron is very quiet. Output is, perhaps, just a little in excess of requirements, but as yet stocks are very small. The strong statistical position fails, however, to maintain values. Demand on home account is very disappointing, and export inquiries are few and small. With customers moving most cautiously and markedly disinclined to commit themselves beyond orders sufficient to satisfy urgent needs, producers are compelled to make price concessions. There are now sellers of No. 1 Cleveland pig at 77*s.* 6*d.*, whilst No. 3 g.m.b. is obtainable at 73*s.*, and No. 4 foundry and No. 4 forge are quoted 72*s.* 6*d.* and 72*s.* respectively.

Hematite.—East coast hematite is abundant. Makers are anxious to liquidate the rather heavy accumulations at their yards, and some firms do not hesitate to accept 78*s.* for Nos. 1, 2 and 3, but others continue to quote up to 79*s.*

Foreign Ore.—There is little or nothing doing in foreign ore. Sellers base market rates on best rubio at 21*s.* 6*d.* c.i.f. Tees, but possibly contracts could be arranged on lower terms.

Blast-furnace Coke.—Durham blast-furnace coke is little sought after and supply is very ample. Though more is asked, orders for good medium qualities can be placed at 21*s.* delivered to local consumers.

Manufactured Iron and Steel.—Nearly all descriptions of manufactured iron and steel are difficult to dispose of, the outstanding exception being sheets, producers of which are not only heavily sold but report continued substantial inquiry. Further sales of constructional steel and of railway requisites are reported.

Manufactured Iron and Steel.—Nearly all descriptions of manufactured iron and steel are slow of sale. Recent reductions in prices of semi-finished steel have failed to tempt buyers into the market, imported materials being still well below the rates named for local products. A few more sales of railway requisites and of constructional steel are reported. Sheet makers are heavily sold, and they state that substantial inquiries are still circulating. Common iron bars are 11*l.* 12*s.* 6*d.*; iron rivets, 13*l.* 10*s.*; packing (parallel), 8*l.*; packing (tapered), 11*l.* 10*s.*; steel billets (soft), 7*l.* 10*s.*; steel billets (medium), 8*l.* 5*s.* to 8*l.* 10*s.*; steel billets (hard), 9*l.*; steel boiler plates, 12*l.* 10*s.*; steel ship, bridge and tank plates, 8*l.* 5*s*; steel rivets, 13*l.*; steel joists, 8*l.* 5*s.*; and galvanised corrugated sheets (No. 24 gauge, in bundles), 16*l.* 10*s.*

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—There has been no change in the state of the steel trade since last report. Fresh orders are very difficult to pick up, and more especially since the trend of foreign exchanges has enabled Continental makers to shade their recent prices. Any business on offer is of small tonnage, and with all quotations tending downwards consumers are very reluctant to fix anything ahead. A few lines have recently been picked up for steel rails, but these do not mean very much activity at the works. Black sheet makers continue to be fairly well employed, but keen prices have to be accepted when any reasonably decent order comes into the market. The makers of galvanised sheets continue fully employed and prices for this variety keep firm. The inquiry for steel material overall is not of any moment either on home or export account. Prices generally have an easier tendency and are round the following: Boiler plates, 12*l.* 10*s.* per ton; ship plates, 8*l.* 12*s.* 6*d.* per ton; sections, 8*l.* 2*s.* 6*d.* per ton; and sheets, $\frac{3}{16}$ in. to $\frac{1}{8}$ in., 10*l.* per ton, all delivered Glasgow.

Malleable Iron Trade.—In the West of Scotland malleable iron trade the prevailing conditions are far from satisfactory. There is an entire absence of demand, and the usual hand-to-mouth state exists at nearly all the works in the district. Inquiries also are poor. In the steel re-rolling branches business is very quiet. Prices are nominally unchanged, and "Crown" bars are quoted at 11*l.* 12*s.* 6*d.* per ton, delivered Glasgow stations.

Scottish Pig-Iron Trade.—A dull tone exists in the Scottish pig-iron trade with a very poor demand. Inquiries are only of moderate dimensions and actual sales do not amount to anything like a fair tonnage. The present consumption of hematite iron is poor and the same is also the case with foundry grades. Prices have an easier tendency and the following may be taken as the current quotations: Hematite, 4*l.* 7*s.* 6*d.* per ton delivered at the steel works; foundry iron, No. 1, 4*l.* 7*s.* 6*d.* per ton, and No. 3, 4*l.* 5*s.* per ton, both on trucks at makers' yards.

Scottish Pig-Iron Shipments.—The shipment of Scottish pig-iron from Glasgow Harbour for the week ending last Saturday, June 13, amounted to 265 tons. Of the total, 238 tons went overseas and only 27 tons coastwise. For the corresponding week of last year the figures were 428 tons overseas and 49 tons coastwise, making a total shipment of 477 tons.

COKE-UTILISATION COMPETITION.—In connection with the coke competition organised by the *Gas Journal*, and referred to in our issue of April 24, page 511, intending competitors are reminded that the latest date for the reception of papers is Tuesday, June 30.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—Quiet conditions are still in evidence in the Welsh coal trade. Tentative inquiries are fairly numerous but actual business is very limited, as buyers are not disposed to pay current prices, while colliery salesmen declare that they cannot lower values further as they are already selling at a loss. Quotations show little alteration, but buyers with firm business can secure their requirements at less than the quoted prices. A shortage of ready shipping is also making matters more difficult, so far as colliery owners are concerned, and temporary pit stoppages are increasing. Best Admiralty large coal rules from 25*s.* 6*d.* to 26*s.*, with Monmouthshires from 22*s.* 6*d.* to 24*s.* 6*d.*, and best steam smalls from 14*s.* 6*d.* to 15*s.* In the past week, 444,150 tons of coal were shipped abroad as cargo from South Wales, compared with 348,160 tons in the preceding week. Of last week's total, 267,560 tons were despatched from Cardiff, 72,400 tons from Newport, 69,050 tons from Swansea, 31,130 tons from Port Talbot, and 3,970 tons from Llanelly. The Argentine took 59,800 tons, Egypt 29,600 tons, France 94,480 tons, Italy 91,750 tons and Spain 41,150 tons.

Ship Repairing.—The Bristol Channel Ship Repairers' Employers' Federation has given formal notice to the trade unions concerned to terminate the present working conditions and wage agreements at Cardiff, Barry, Swansea and Newport, in view of the depression which is prevalent. It is proposed to substitute the national rate of time and a half in place of the present rate of double time for all overtime work, while for "dirty" work an increase of 10 per cent. on the base rates is suggested in place of the present rate of time and a quarter. It is also proposed that the allowance of 50 per cent. paid to men working more than 15 ft. above the deck shall be abolished and replaced by an allowance of 10 per cent. It is also proposed to abolish the "lieu" rate, which is now confined to boilermakers, and that a more comprehensive scheme of piece-work rates should be introduced. In regard to payment for work on oil vessels, the National Employers' Federation are at present discussing new arrangements, which when completed will apply to the Bristol Channel ports. A proposal has also been made that, in the event of disputes ending in a total deadlock, the question shall be referred for arbitration to an independent person mutually agreed upon.

Iron and Steel.—Exports of iron and steel goods in the past week amounted to 14,005 tons, compared with 8,746 tons in the previous week. Shipments of tinplates and terneplates totalled 2,988 tons against 3,908 tons, blackplates and sheets 4,710 tons against 755 tons, galvanised sheets 3,990 tons against 1,303 tons, and other iron and steel goods to 2,317 tons against 2,780 tons.

THE INSTITUTION OF CHEMICAL ENGINEERS.—The Institution of Chemical Engineers has recently started an Appointments Bureau and is receiving private information regarding posts of importance. It is hoped that all those who have appointments vacant will furnish particulars of them to the Bureau, Abbey House, Westminster, S.W.1.

THE PRODUCTION OF IRON AND STEEL.—According to figures supplied by the National Federation of Iron and Steel Manufacturers, the production of steel ingots and castings in May of this year amounted to 651,600 tons, compared with 597,600 tons in April and 809,700 tons in May, 1924. The pig-iron produced in April and May, 1925, and May, 1924 amounted to 569,800 tons, 568,000 tons and 650,900 tons, respectively.

LAUNCH OF THE S.S. "JEVINGTON COURT."—Built to the order of Messrs. Haldin and Co., Limited, London, for cargo service, the S.S. "Jevington Court" was launched from the South Yard of Messrs. Workman, Clark and Co., Limited, Belfast, on June 9. A departure has been made in adopting the complete shelter deck type for this, the fourth vessel recently built by Messrs. Workman, Clark and Co., for the same owners. The "Jevington Court" has a gross tonnage of 4,600 and is 410 ft. in length; she possesses a very complete outfit of winches and derricks and has five large holds arranged for the carriage of grain and general cargo. The engines, also built by Messrs. Workman, Clark & Co., are of the triple-expansion type driving a single screw. The accommodation provided for officers and crew is most comfortable and modern. It is expected that the vessel will be ready for service early in July.

WORKS ACCIDENTS.—The recently issued Technical Paper 374 of the U.S. Bureau of Mines deals with accidents at metallurgical works in the United States during the year 1923. The paper states that 54,418 men were employed during 1923 at ore-dressing plants, smelting, and auxiliary works; iron blast-furnace plants are not included, as accident reports relating to these are not received by the Bureau of Mines. The average number of working-days per man amounted to 332, representing a total of over 18 million days of labour. The number of shifts worked was upwards of four millions in excess of the number reported for 1922. During 1923, 58 workmen were killed in works accidents and 8,476 were injured, indicating a fatality rate of 0·96 and an injury rate of 141 per 1,000 full-time workers. For 1922, the corresponding rates were 0·98 and 145, respectively. Of the total number of accidents, only 0·01 per cent. resulted in permanent total disability, and 70·98 per cent. caused temporary disability for a period not exceeding 14 days.

NOTICE OF MEETING.

THE SOCIETY OF GLASS TECHNOLOGY.—Wednesday, June 24, at 2.30 p.m., at the University College, Gower-street, W.C. 1. "An Attempt to Improve the Quality of Glasses for Lamp-working," by Professor W. E. S. Turner, D.Sc. "A Study of the Influence of Boric Oxide on the Properties of a Glass intended for Chemical Resistance Purposes": Part I, "The General Properties of Glasses"; Part II, "The Influence of Boric Oxide on the Physical Properties of the Glasses"; Part III, "The Effect of Boric Oxide on the Durability," by Professor W. E. S. Turner, D.Sc., and Mr. F. Winks, B.Sc.

TRIAL TRIP OF THE S.S. "BELVOIR."—The S.S. Belvoir, built at Wallsend for the International Waterways Navigation Co., Limited, of Montreal, by Messrs. Swan, Hunter and Wigham Richardson, Limited, successfully passed her trials recently. Built to Lloyd's requirements, the vessel is specially designed for service on the Canadian lakes, canals, and on the River St. Lawrence. The ship has four cargo hatchways, and water ballast is carried in the forward and after peaks as well as in the double bottom fore and aft. The engines, which have been built by Messrs. MacColl and Pollock, of Sunderland, are placed at the after end of the ship and drive a single propeller. The engine-room staff are housed aft, and the captain, officers, and seamen in the fore end of the vessel. Electric lighting and steam-heating have been installed throughout. The windlass has been made by Messrs. Harfield and Co., Limited, Blaydon-on-Tyne.

THE UNITED STATES CEMENT INDUSTRY.—*Cement in* 1923 is the title of a pamphlet by Messrs. E. F. Burchard and B. W. Bagley, issued by the Geological Survey of the U.S. Department of the Interior and published at the Government Printing Office, Washington. It states that Portland cement was made at 126 plants in 1923, compared with 118 in 1922. The total number of rotary kilns in plants operating in 1923 was 793, an increase of 33 over the previous year. Recent studies by engineers indicate that the diameter of a kiln should be considered as well as its length, and, in the belief that an increased clinker output would result, some firms have increased the diameter of the lower end of their kilns. In the majority of cases, the fuel used is coal, but some plants utilise crude oil, or natural gas, or a mixture of fuels. During the last six years, cement manufacturers have been installing waste-heat boilers to an increasing extent. The generation of steam for the purpose of operating the machinery of the plant, by utilising the heat contained in the gases escaping from the kilns, probably constitutes the greatest improvement in the equipment of cement factories in recent years.

REFRACTORY MANGANESE-SILVER ORES.—The results of experimental work on the metallurgical treatment of refractory manganese-silver ores, undertaken by the U.S. Department of the Interior in co-operation with the Netherlands East Indies Government, are given in Bulletin 226, by G. H. Clevenger and M. H. Caron, issued recently by the U.S. Bureau of Mines, Washington, D.C. Owing to the intimate association of the manganese and silver in these ores, all methods of concentration and direct lixiviation of the raw ore, or of ore calcined under oxidising conditions, have proved unsuitable. The silver contained in this stubborn material has now, however, been rendered amenable to cyanidation by a special treatment known as the Caron process, which consists in heating the ore in a reducing atmosphere so as to reduce completely the higher oxides of manganese to manganous oxide, and cooling in such a way as to prevent reoxidation. The Clevenger furnace and cooler unit has been developed in connection with the above process. Its use enables reduction to be obtained with high fuel economy, and reversion to the refractory state is prevented. The Caron process has proved generally effective in the treatment of manganese-silver ores, material containing antimony being the only exception that has been found up to the present.

SINGLE-SCREW CARGO MOTOR SHIP.—Recently Messrs. Barclay, Curle and Co., Limited, launched from their Clydeholm Shipyard, at Whiteinch, a single-screw cargo motor ship. The vessel, which is of the single-deck type, has a complete shelter deck and topgallant forecastle, while the dimensions are: length, 410 ft.; breadth, 55 ft. 3 in.; and moulded depth to upper deck, 29 ft. The deadweight will be 9,350 tons, the gross tonnage 6,500, and the speed 11 knots. A steel centre-line bulkhead extends through the holds, and arrangements have been made to permit feeder trunks and shifting boards to be fitted expeditiously for the carriage of grain. Ballast tanks in the double bottom, excepting the one below the main engines, are intended to carry either oil fuel or water. The propelling machinery, of British design, has been constructed by the North British Diesel Engine Works (1922), Limited, at Whiteinch, and consists of a double-acting two-stroke Diesel engine, having three cylinders 24½ in. in diameter and 44 in. in stroke, developing 2,000 brake horse-power at 100 r.p.m. Tests carried out at the works have proved that fuel oil of ordinary boiler quality, having a specific gravity of 0·95, can be successfully used in the engine, the consumption being some 9¾ tons per day. The straight-through scavenging of the waste gases and the absence of air and exhaust valves are claimed to facilitate use of fuel not specially refined. A similar equipped ship recently completed, the motor ship Swanley, we are informed, is giving satisfactory service.

THE NEW SHOREHAM BRIDGE OVER THE ADUR.

CONSTRUCTED TO THE DESIGNS OF MESSRS. HOWARD HUMPHREYS AND SONS, CONSULTING ENGINEERS, WESTMINSTER.

(*For Description, see Page* 755.)

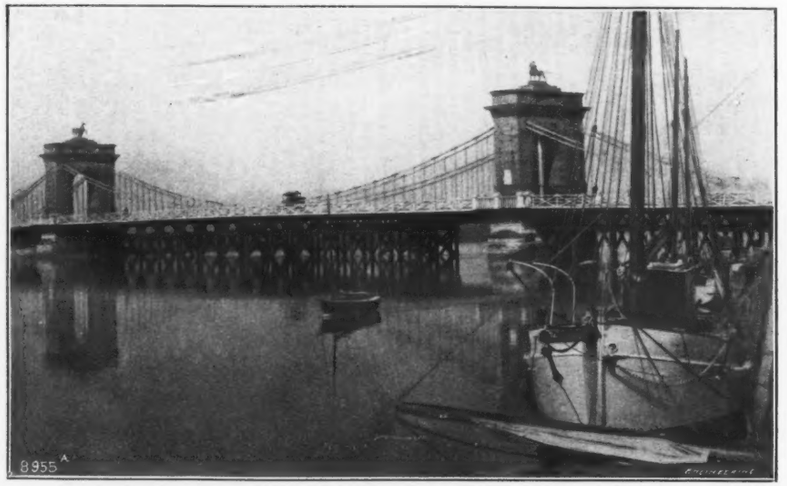


FIG. 56. TEMPORARY TIMBER SHORING FOR STRENGTHENING THE OLD BRIDGE PRIOR TO RECONSTRUCTION.

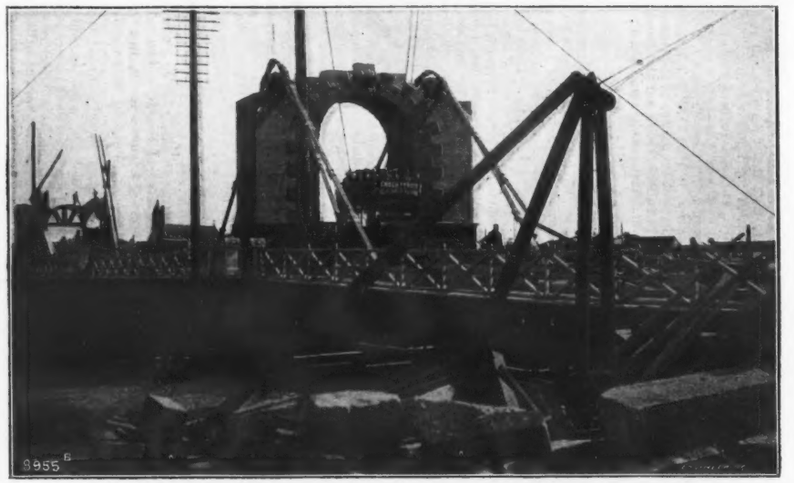


FIG. 57. PARTLY DISMANTLED CHAINS AND TOWERS OF THE OLD BRIDGE.

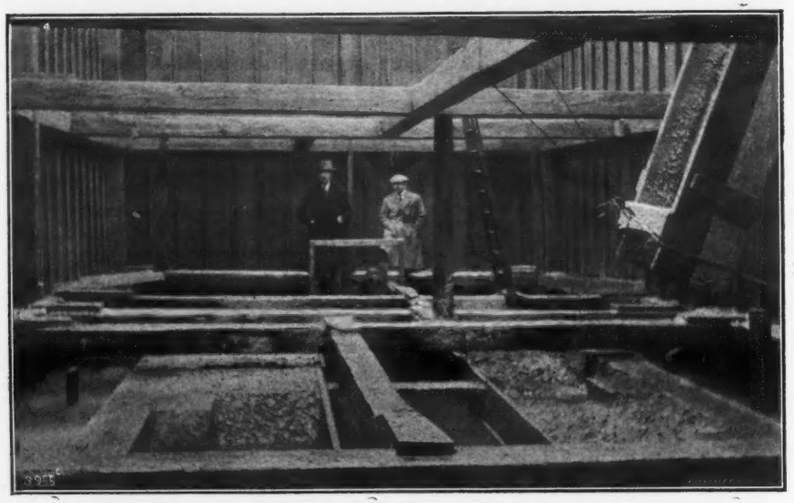


FIG. 58. NEW CENTRAL PIER SHOWING CENTRAL CAVITY AND HEARTING.

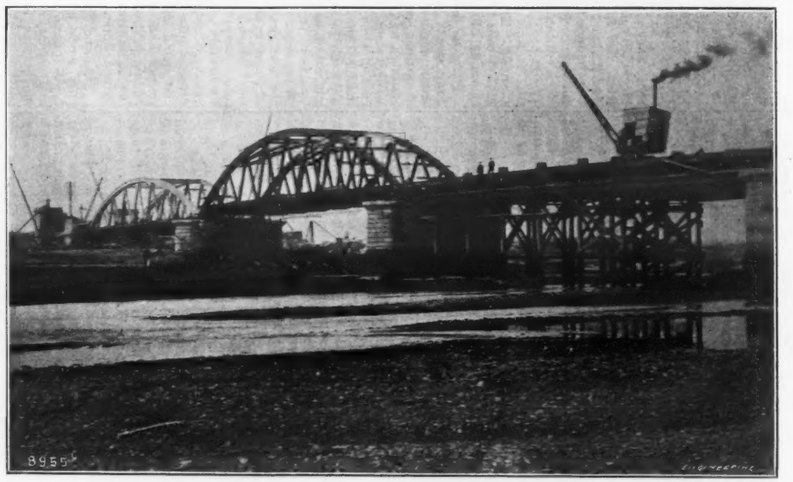


FIG. 59. TWO WEST SPANS OF NEW BRIDGE IN COURSE OF ERECTION.

THE NEW SHOREHAM BRIDG

CONSTRUCTED TO THE DESIGNS OF MESSRS. HOWARD HUMPHREYS

(For Description, see Pa

Fig. 35.

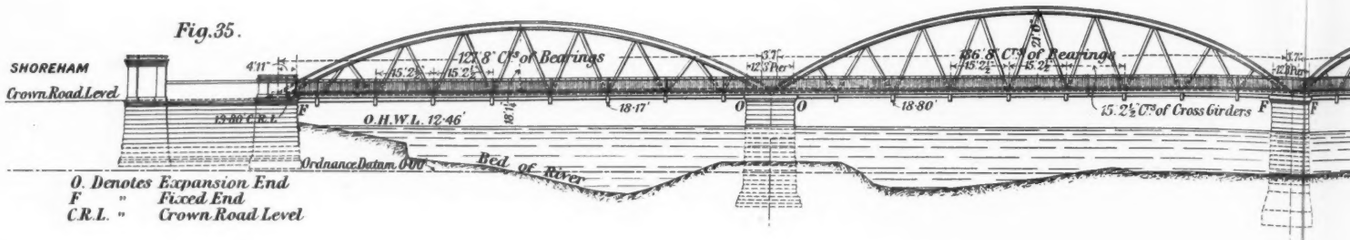


Fig. 36.

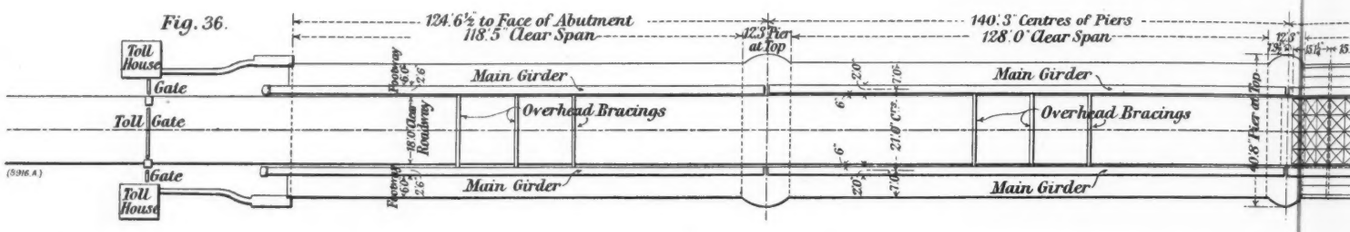


Fig. 38.

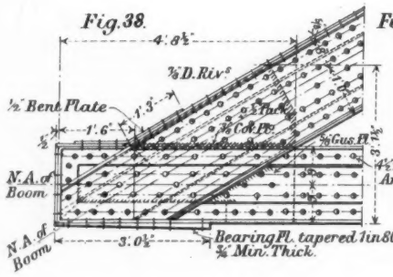


Fig. 39.

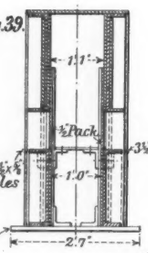


Fig. 40. DIAPHRAGM TOP BOOM.

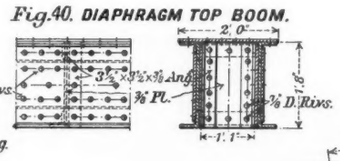
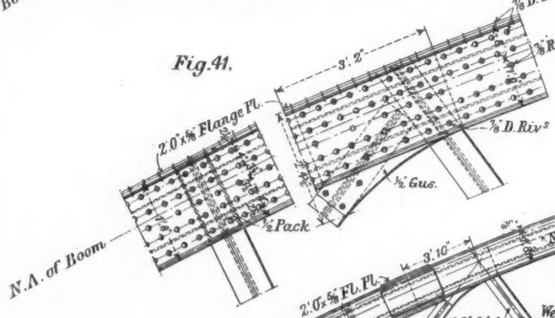


Fig. 41.



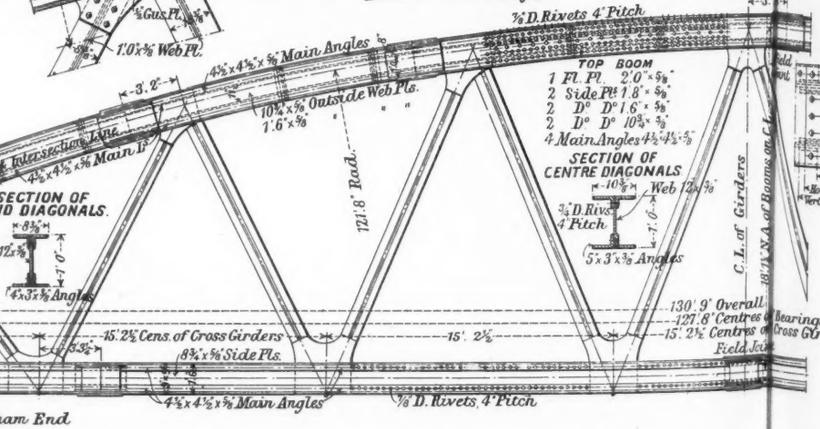

⅜ D. Rivets 4" Pitch
4½" x 4½" x ⅝ Main Angles
10½" x ⅝ Outside Web Pls.
1'6" x ⅝
N.A. Intersection Line
Main L^s
TOP BOOM
1 Fl. Pl. 2'0" x ⅝
2 Side Pl^s 1'8" x ⅝
2 D^o D^o 1'6" x ⅝
2 D^o D^o 10½" x ⅝
4 Main Angles 4½" 4½" ⅝
SECTION OF CENTRE DIAGONALS
Web 12" x ⅜
3" D. Rivs. 4" Pitch
5" x 3" x ⅜ Angles
SECTION OF END DIAGONALS.
Web Pl. 17" x ⅜
4" x 3" x ⅜ Angles
121'8" Rad.
C.L. of Girders
N.A. of Booms
Flange Pl.
Web Pl.
Gus.
Pack

Fig. 37.

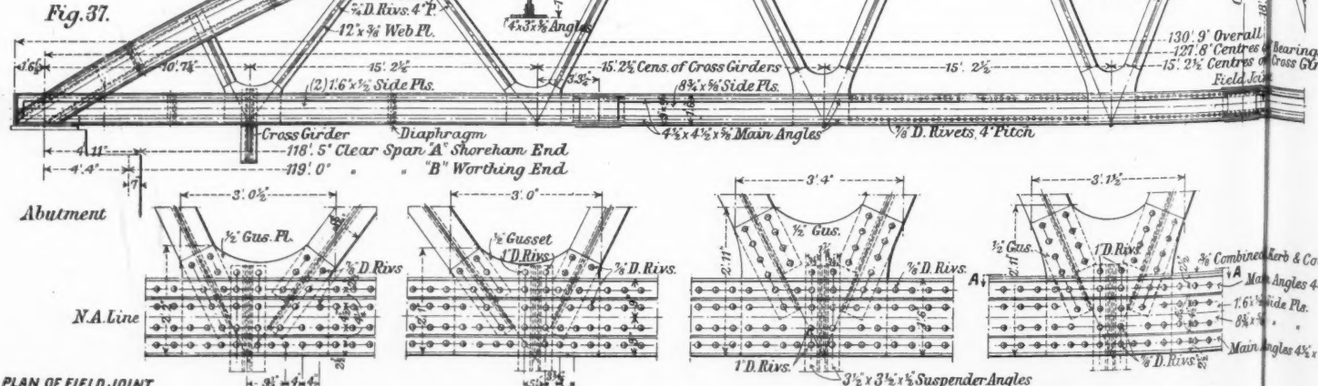
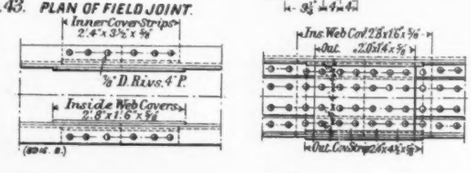


Fig. 43. PLAN OF FIELD JOINT.



SEC. THROUGH JOINT.

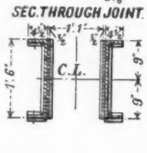


Fig. 44. DIAPHRAGM, BOTTOM BOOM.

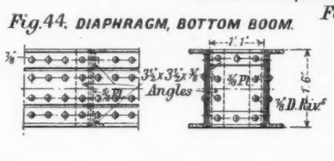
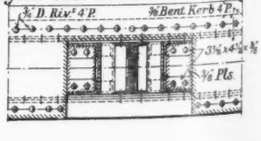


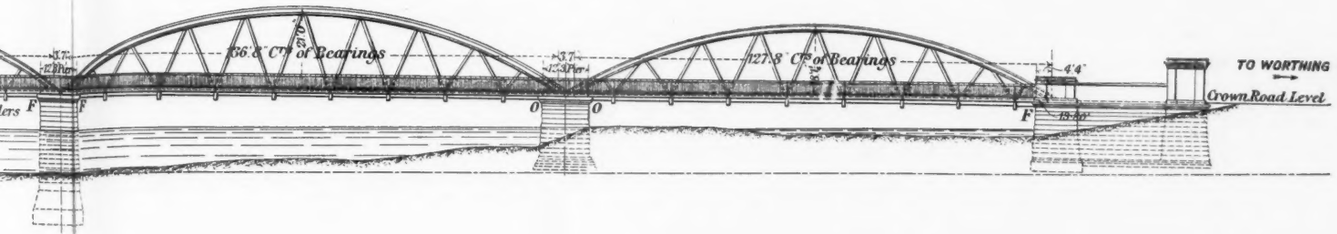
Fig. 45. SECTIONAL PLAN ON A.A.

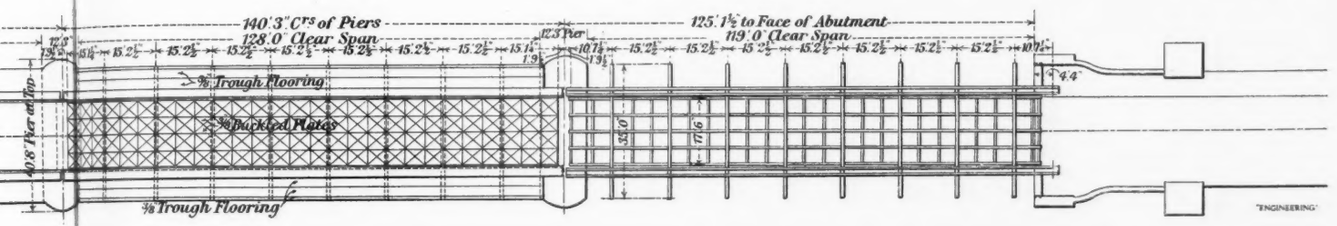


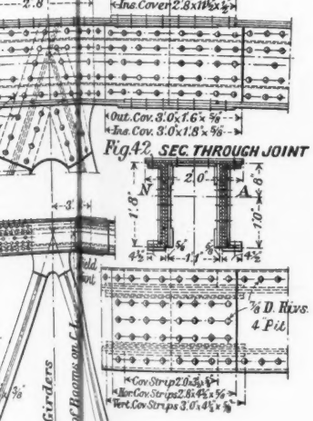
I BRIDGE OVER THE ADUR.

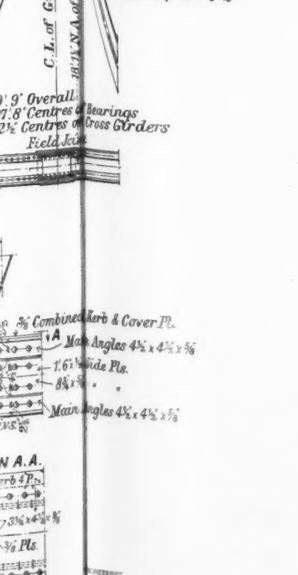
D HUMPHREYS AND SONS, CONSULTING ENGINEERS, WESTMINSTER.

(Description, see Page 755.)









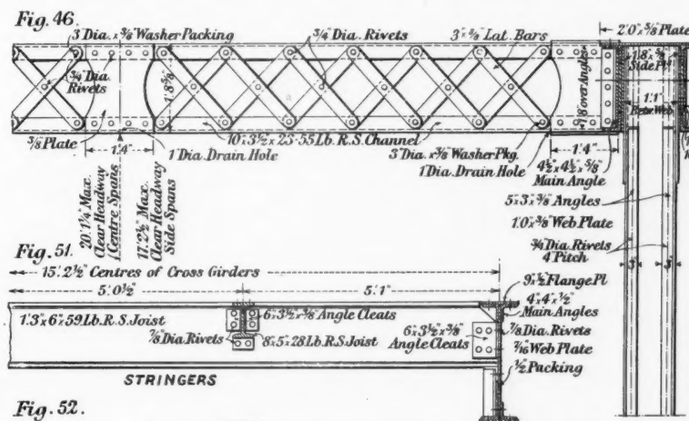
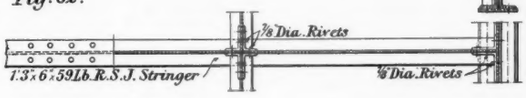


Fig. 46.
3 Dia. x ⅜ Washer Packing
¾ Dia. Rivets
3" x ⅜" Lat. Bars
2'0" x ⅜" Plate
⅜" Plate
1 Dia. Drain Hole
10" x 3½" x 23·55 Lb. R.S. Channel
3 Dia. x ⅜ Washer Pkg.
1 Dia. Drain Hole
4½" x 4½" x ⅝" Main Angle
5" x 3½" x ⅜" Angles
1'0" x ⅜" Web Plate
¾ Dia. Rivets 4 Pitch
20'1" Max. Clear Roadway (Centre Spans
17'2" Max. Clear Headway Side Spans



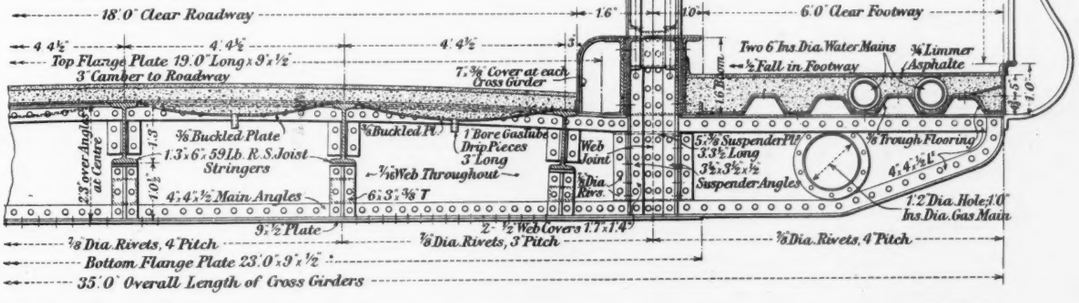


Fig. 49.
21'0" Centres of Main Girders
18'0" Clear Roadway
6'0" Clear Footway
Top Flange Plate 19'0" Long x 9" x ½"
3" Camber to Roadway
Two 6" Ins. Dia. Water Mains
½" Fall in Footway
¾" Limmer Asphalte
⅜" Buckled Plate
13" x 6" x 59 Lb. R.S. Joist Stringers
⅜" Web Throughout
4" x 4½" x ½" Main Angles
6" x 3½" x ⅜" T
⅜" Trough Flooring
5" x ⅜" Suspender Pls.
3" x 3½" x ½" Suspender Angles
1'2" Dia. Hole for 10" Ins. Dia. Gas Main
9" x ½" Plate
2" x ½" Web Covers 1'7" x 1'4"
⅞ Dia. Rivets, 4 Pitch
⅞ Dia. Rivets, 3 Pitch
Bottom Flange Plate 23'0" x 9" x ½"
35'0" Overall Length of Cross Girders

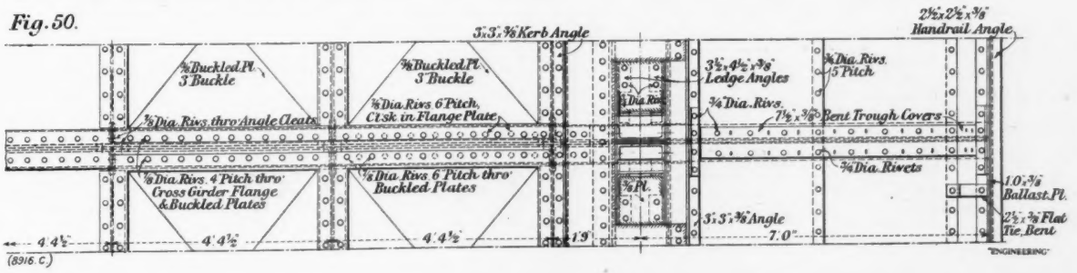
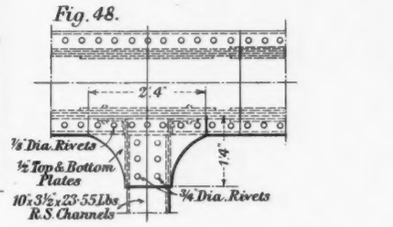


Fig. 50.
5" x 3½" x ⅜" Kerb Angle
2½" x 2½" x ⅜" Handrail Angle
⅜" Buckled Pl. 3 Buckle
⅞ Dia. Rivs. thro' Angle Cleats
⅜" Buckled Pl. 3 Buckle
⅞ Dia. Rivs. 6 Pitch, C'sk. in Flange Plate
3½" x 4½" x ⅜" Ledge Angles
¾ Dia. Rivs. 5 Pitch
¾ Dia. Rivs.
7½" x ⅜" Bent Trough Covers
⅞ Dia. Rivs. 4 Pitch thro' Cross Girder Flange & Buckled Plates
⅞ Dia. Rivs. 6 Pitch thro' Buckled Plates
¾ Dia. Rivets
1'0" x ⅜" Ballast Pl.
2½" x ⅜" Flat Tie Bent
5" x 3½" x ⅜" Angle
7'0"
4'4½"
(8916. C.)
"ENGINEERING"



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Two-Page Plate.—THE NEW SHOREHAM BRIDGE OVER THE ADUR.

ENGINEERING.

FRIDAY, JUNE 19, 1925.

JAPANESE NAVAL AIMS.

ALTHOUGH there have been frequent references to Japanese naval strength, both in the British and American press, it is rather curious that no naval writer has, as yet, attempted to analyse the composition of the Japanese fleet, in order to get some idea of the strategical purposes for which it is probably intended. At first sight the problem would appear insoluble without reference to secret archives; but, in point of fact, it is by no means very difficult, for the Japanese navy can only be required for ensuring the flow of vital commodities to the islands in case of war, or for overseas operations. It will be interesting to take each of these points in turn, and examine them as closely as statistics and known facts allow.

Any country which is dependent upon overseas supplies must first ensure itself an adequate food supply and, after that, secure sufficient quantities of raw materials for its war industries and munition factories. What are the naval commitments which attach themselves to each of these *desiderata*?

The principal articles of the Japanese national diet are rice, beans, wheat, fish, meat, sugar, and salt; and of these rice is the most important. Except in the case of fish, the country imports a proportion of its total consumption of all these items; but the sources of supply are fairly concentrated. All the rice, meat, and salt required for keeping the population in health can be obtained from China, Korea, and Formosa. The sugar is, it is true, largely obtained from the Dutch East Indies, but, in an emergency, sugar imports could certainly be cut down, and enough sweetening matter obtained from the very large supplies of home-produced honey. The wheat imports undoubtedly contain the germ of a serious strategical problem. At the present moment about half come from the American continent and half from China; but the import total grows year by year, and there is a tendency to depend more and more upon the American market.

British import statistics during the war have proved that a country can supply large armies on decreased imports of iron, coal, and ores; but that a large increase in imported oils and chemicals is inevitable. (See Fayle, "History of Sea-borne Trade," vol. iii, Appendix CIX, page 478.) The exact quantities of each which are essential depend upon a country's military commitments. A glance at the Japanese trade returns shows that the country would be able to secure itself all the iron, coal, and copper it needed from Chinese sources of supply; but that petroleum and rubber can only be obtained from America and the Dutch East Indies. A great effort has, however, been made to use the Dutch supplies as much as possible, for only about a quarter of the total imports of oil fuel come from the American Continent. Chemicals are, undoubtedly, obtained largely from Europe; but, as a total supply of 2,500,000 tons would probably suffice for a three-years war, large reserves can always be obtained in peace. For rubber and cotton the country is mainly dependent upon the Dutch East Indies and British India, although a certain percentage of cotton comes from America.

These facts leave no doubt as to the exact nature of the Japanese naval problem. The area enclosed by Korea, the Japanese islands, the Liu Kiu group and Formosa, on the east and north, and by the Chinese mainland on the west, must be secured against any adversary. From inside that area Japan can supply herself with the bulk of what she requires in war. If it is lost—that is, if Japan's communications with China are cut by an adversary which establishes a naval force in the China seas—her capacity for resistance will cease automatically. That, however, is only part of the problem. The country's dependence upon the Dutch East Indies would increase enormously in war; and as her home production would probably fall off as men were taken from agriculture and industries, it would be essential that she should keep open one overseas line of supplies. If she were at war with a European Power, great efforts would doubtless be made to make the American route secure; and if with the United States, to keep communications open with British India and Europe.

An analysis of the present state of the Japanese navy shows, without doubt, that those responsible for the country's naval policy have concentrated all their thought upon the purely defensive aspects of the naval problem. The Japanese navy is admirably designed to keep opponents out of the vital area between Japan and the Chinese mainland; but it is far less well equipped to support overseas operations, or even to protect long lines of communication. The latest units of the cruiser fleet—that is, the 16 ships of the Yubari, Kinu and Tatsuta class—are all of the fleet-cruiser type; 13 of them are of the 5,000-ton class, the remaining three are smaller. The implication is obvious: all the newest cruisers are to be used for fleet-scouting duties inside the Japanese narrow seas. The remaining cruisers are, it is true, much heavier, and might certainly be used for escort or patrol work along an ocean route; but there are only 11 of them, and of these, six are twenty-five years old.

The existing building programme shows the same purely defensive tendencies. The three vessels of the Kinu type are 5,000 ton fleet cruisers; the remaining six (four Furutakas and two Myokos) are of heavier tonnage; but when put into service they will only replace the old cruisers which were completed in 1899. No system of calculation can give the Japanese more than ten oceanic cruisers, capable of defending or disturbing distant communications, when their present programme is completed. Seeing how important it may be to keep open at least one of the transoceanic routes, one has to admit that they propose to do it with a very minimum of force. A quantitative test of the Japanese petroleum requirements in war accentuates her dependence upon overseas sources of supply, and, indeed, her difficulty in obtaining what she would need if she were ever engaged with a powerful naval adversary. Her total yearly imports are, at present about 1,450,000 tons (petroleum and benzine): she would require about two and a-half times as much if a comparison between the British figures for 1913 and 1918 is any guide at all. This means either that the country must accumulate a

reserve of some seven million gallons for a three years war, or else that some three and a-half million additional gallons must be brought into the country over long oceanic communications during every year she is at war. This, it must be admitted, is a tremendous commitment, and one the Japanese naval staff could hardly undertake with the purely defensive force at present at its disposal.

The composition of the Japanese destroyer and submarine fleets leads irresistibly to the same conclusion. There are only 29 first-class boats, that is, destroyers of more than 1,000 tons in service, and when their new units are completed they will hardly have 50 in all. These are small figures, and it should be remembered that no destroyer of any tonnage is really fitted for oceanic work.

The Japanese submarine fleet can be dealt with even more briefly. Their submarines are all adapted for work in the China seas, and they only possess two boats which could operate as far south as the Dutch East Indies.

The Japanese have, indeed, two peculiar reasons for concentrating upon that smaller, coastal, type of submarine which French naval experts call a *sous-marin de blocus*. First, Japanese foreign trade is concentrated at Yokohama and Kobe, so that any dislocation at these two places would automatically upset the distribution of supplies over the whole country; secondly, the carrying capacity of Japanese railways is low, with the consequence that the coasting trade is a very important factor in the general machinery of distribution. Strong coastal patrols and a powerful mobile defence at the great commercial harbours are the naval corollaries to this dependence upon two centres of distribution, Yokohama and Kobe, and the economic importance of the coastal routes. The Japanese submarine fleet seems to have been specially designed for these purposes; but, it has to be admitted that it is numerically weak. A very large number of submarines would be required for operations in the sea of Japan, and the surplus available for work round the Japanese coasts would not be great. All facts therefore combine to prove that the Japanese navy is designed to defend the vital economic interests of the country, and is not adapted to disturbing an adversary's communications. It may even be asked, how, in its present composition, it could successfully defend the European route from Singapore northwards, against a determined attempt to cut it. The goods which the Japanese would need most would probably be food stuffs from British India, and oil and rubber from the East Indies. There would be ample precedent for treating all as contraband, in which case the neutral flag would not cover them. The ten or eleven heavy cruisers available for protecting the traffic would hardly suffice to put it under escort; and if an enemy succeeded in operating from Manila against the route, no other measure would suffice to ensure the safe arrival of the essential cargoes.

On these facts it seems safe to sum up the present Japanese programme by saying that it hardly provides an adequate defence for the country's growing dependence upon overseas supplies. If, during the next few years, the Japanese Government make provision for more cruisers and submarines of the oceanic type, it will certainly be unjust to accuse them, on that account, of departing from the cautious defensive policy which at present animates their whole system of naval defence. Any Japanese government could undoubtedly make out an unanswerable case for having at least 20 heavy cruisers, capable of oceanic work along distant communications, and a large force of submarine cruisers. At present they are contented with a far lower figure, and show no desire to increase it.

FARADAY AND THE BENZENE CENTENARY.

ON June 16, 1825, Michael Faraday, chemical assistant in the Royal Institution, read before the Royal Society, a paper on "A New Compound of Carbon and Hydrogen obtained by Decomposing Oil by Heat." The liquid, which froze at 0 deg. C. and which he called "bicarburet of hydrogen," contained "2 proportionals of carbon and 1 proportional of hydrogen," the vapour "6 proportionals of carbon and 3 of hydrogen"; in modern molecular nomenclature it was benzene, C_6H_6. The bicarburet was not the first hydrocarbon which Faraday and others had isolated; olefiant gas and naphthalene, for example, were known, and Faraday had previously obtained what would now be called a hexachlorobenzene. The preparation was not a synthetic process, breaking down the boundary between organic and inorganic chemistry, such as that adopted in 1828 by Wöhler when he prepared urea from potassium cyanate and ammonium sulphate. Faraday, convinced that organic and inorganic compounds were subject to the same laws, was not particularly concerned about organic or inorganic questions. A few years later Mitscherlich in Berlin obtained, by distilling (with lime) benzoic acid—long known as a constituent of some aromatic resins—a hydrocarbon benzoin or benzol, which he identified by comparison with a sample of Faraday's bicarburet. Mitscherlich also isolated azocompounds and the heavy oil nitrobenzol, which Zinin in Kasan (Russia) reduced to aniline. Experimenters with aniline noticed the peculiar colours of their products, and in 1856 William Perkin isolated his mauve, the first coal-tar colour. A. W. Hofmann had extracted benzene from coal tar in 1845. Thus the great coal-tar industry and the chemistry of aromatic compounds, in their vast, beneficial and destructive ramifications, built upon the simultaneous development of constitutional chemistry, sprung from Faraday's discovery of benzene, and for this reason the "Faraday Benzene Centenary" has been celebrated in the Royal Institution.

Faraday himself did not take a prominent part in this further development. Electric phenomena soon usurped his attention and overshadowed his early work; in 1931 the World will celebrate the centenary of his discoveries of electromagnetic induction and of the laws of electrolysis. He did, however, signal work as a chemist. Born 1791 in Newington Butts, London, where his father, a Yorkshire blacksmith, had settled, he had drawn with other poor his one loaf of bread weekly in the famine year 1801. Apprenticed to a bookbinder, he studied scientific books within his reach, attended lectures, including a few by Sir Humphry Davy, and applied for and secured, partly on the excellence of his lecture notes, the vacant post as Davy's assistant in 1813. In one of their first experiments master and assistant were injured by an explosion of nitrogen chloride. He accompanied Davy on an eighteen months' journey to France, Switzerland and Italy—his only long journey—and took up rooms in the Royal Institution in 1815, where from 1833 onwards he mostly resided, as Fullerian Professor of Chemistry, till his death in 1867, though failing health obliged him in later life to resign some of his duties, and to decline the presidency of the Royal Society.

His oil researches were undertaken on the appeal of the Portable Gas Company, which made oil gas by dropping fish oil into hot retorts and compressed it at 30 atmospheres (as Faraday states) in steel cylinders. Complaints arose that the gas deteriorated when kept in cellars. Faraday found that an oil was deposited in the cylinders; the oil gave benzene and other compounds, which brightened the gas to which it was added and made excellent solvents for oils and rubber which he was studying; benzene soon became a favourite among cleansing materials. Faraday also rendered naphthalene soluble by converting it into a sulphonic acid as is done in dyeworks. He made investigations on lime and on steel and other alloys, and he liquefied chlorine and other gases by their own vapour pressure in sealed tubes. Investigating optical glass, he found that the colour of ruby glass was due to minute particles of finely-divided gold, which he also obtained by reducing solutions of gold salts; some of his colloidal gold solutions are still intact. With his heavy lead glass he discovered the rotation of the plane of polarisation in a magnetic field. His book on "Chemical Manipulation" is still capable of teaching chemists how to work neatly and systematically. His correspondence with Schönbein proves that he had singularly advanced views on the connection of colour with physical and chemical constitution. Though corresponding with many of the great of his time he worked practically alone. An experimental genius and a philosopher of high imaginative originality, he combined a certain shrewdness—the young lecturer understood quite well how a lecturer should treat his audience—and a belief in experimental facts with pure-minded kindliness and the child's religious faith.

This week's jubilee celebrations in connection with benzene has had predecessors. The first of these had reference to a theoretical achievement. By 1865, Professor August Kekulé von Stradonitz, of Bonn, had proved that the remarkable reactions and isomerisms of aromatic compounds—half of modern chemical research deals with these—indicated that the six carbon and six hydrogen atoms of benzene were bound in a hexagon of peculiar stability. Various modifications of the Kekulé-hexagon have been proposed; in its essential conception it stands now on much firmer ground than in 1890, when a large international gathering, held in Berlin, celebrated the 25th anniversary of Kekulé's benzene ring. In 1891 the centenary of Faraday's birth was celebrated at the Royal Institution. The great fifty year jubilee anniversary of the tar-colour industry was celebrated in 1906,* when chemists and others from all over the world offered their congratulations to Sir William Perkin, who, it will be remembered, did not survive by much more than a year.

This year's festivities were arranged by the Royal Institution in association with the Chemical Society, the Society of Chemical Industry, and the Association of British Chemical Manufacturers. Professor Henry E. Armstrong was chairman of the committee. General invitations were not issued to Fellows of the two societies mentioned, and a selection seems to have been made in connection with the invitations sent to foreign scientific bodies. The celebrations comprised a discourse by Sir W. J. Pope, of Cambridge, on "Faraday as a Chemist," delivered on June 12, a reception of the delegates from abroad and the Dominions at the Royal Institution, and a banquet at the Goldsmiths' Hall, E.C., both held on June 16, under the presidency of the Duke of Northumberland, President of the Royal Institution. At the reception, addresses were delivered by the President, Professor Armstrong, Professor E. Cohen, of Utrecht, Professor E. Bertrand, of Paris, and many others. It was announced that the first Centennial Faraday Medal had been awarded to Mr. James Morton, of Scottish Dyes, Limited, for ten years' signal work on fast anthracene dyestuffs and their application to silk and wool.

CONVERSAZIONE OF THE INSTITUTION OF CIVIL ENGINEERS.

THE conversazione of the Institution of Civil Engineers was held on the evening of Wednesday last, and was enjoyed by a large and representative gathering. The visitors were received by the President, Mr. Basil Mott, assisted by Mrs. Adrian Mott and Mrs. Mark Mott. The programme of entertainments included vocal and instrumental music, a series of lectures, and the usual exhibition of engineering models and scientific apparatus, several of which were demonstrated by the exhibitors. The lectures were all illustrated by lantern slides, and were on "Progress of the Steam Locomotive During the Last Century," by Sir Henry Fowler, K.B.E., LL.D.; "Reminiscences of the Mount Everest Expedition, 1924," by Mr. N. E. Odell; and on "Air Transport," by Air Vice-Marshall Sir W. Sefton Brancker, K.C.B., A.F.C. Space does not permit of our describing the exhibition of models and apparatus in any great detail. A collection of documents, pictures, &c., was exhibited by Mr. Isaac Briggs, illustrating the early history of English railways from 1821 to 1850, and attracted considerable interest in view of the approaching railway centenary. Among the exhibits of a general nature may be mentioned specimens of timber piles recently extracted from an old bridge at Poole, exhibited by Sir Brodie H. Henderson; a number of microscopic exhibits of dust from different sources by Dr. J. S. Owens, who

* See ENGINEERING, August 3, 1906, page 149.

also demonstrated the Brownian movement of smoke particles; and models of locomotives and railway coaches exhibited by Mr. E. C. Haughton, Col. F. A. Cortez-Leigh, the Swiss State Railways, and others.

An exhibit of especial interest was a sectional model of a new form of steam meter, exhibited by Mr. J. L. Hodgson. This is being manufactured by Messrs. George Kent, Limited, of Luton, and is illustrated in section in Fig. 1 below. Referring to this, it will be seen that a portion of the steam passing through the instrument is diverted by means of an orifice plate through nozzles A, by means of which it is caused to impinge on a turbine. The speed of this turbine is kept low by means of a damping fan C, which rotates in water,

Fig. 1.

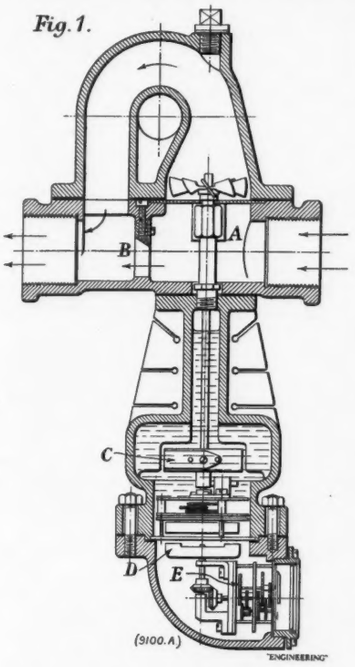
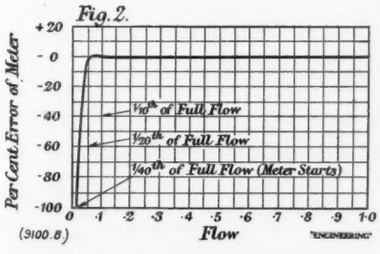


Fig. 2.



resulting in a minimum of wear on the turbine bearings. The retarding torque at any given speed due to this fan is made so great that any variation in the corresponding torque due to the turbine, caused by variations in the density of the steam in which it rotates, can be neglected. The turbine rotates at normal flows with a speed proportional to $Q/\sqrt{W}$ where Q is the weight of steam passing per second, and W is the density of the steam in pounds per cubic foot. From this it will be seen that a variation of 2 per cent. in the density of the steam will involve a correction of only 1 per cent. in the flow reading. Besides reducing wear on the pivots, the use of the damping fan increases the range of the meter, since it increases the relative velocity between the impinging steam and the turbine. As will be seen from the figure, the counter E is mounted in a compartment below the main, a magnetic drive D from the turbine being employed so that leakage of steam or water into this compartment is impossible. Radiating fins assist in keeping the counter cool. The maximum flow which the meter will measure can be altered by changing the orifice plate B; and by fitting a blank plate in place of this orifice plate, and putting the meter in a bye-pass in a large main into which a suitable orifice plate is inserted directly, the largest mains can be metered at a small cost. In Fig. 2 a typical calibration curve for the meter is shown, reduced to steam at constant density on the upstream side of the meter. From this curve it can be seen that pivot friction has an appreciable effect at very small flows only, and that at normal rates, the ratio of the revolutions per minute to the rate of flow is constant.

Another exhibit which attracted considerable interest was a model in wood of a new automatic railway coupling, exhibited by Mr. H. W. S. Husbands. The circular heads of the coupling have three projecting jaws. The faces of these jaws form the buffing surface, and are in the form of a portion of a screw thread, undercut towards the rear to form a hook. The jaws are extended outwards to form horns to guide the heads into alignment. On meeting, the cam surfaces engage and rotate the heads with a wrist-action motion against springs. After the noses have passed, these springs turn back the heads, and the hooks engage, making a tight joint. For uncoupling, either head is rotated against the spring by means of any suitable device, and is retained in the open position by a spring pawl. Arrangements are made for carrying the various train pipes through the coupling.

Amongst the remaining exhibits, mention may be made of a number of gyroscopic tops and other models exhibited by Professor J. G. Gray. One of these models illustrated a new application of gyroscopic principles to a monorail car. In this mechanism the car was articulated, the front portion carrying the gyroscope with the wheel vertical, and in the plane of motion, the rear portion carrying the tractive element. When the car inclined to one side, the articulation resulted in the axes of the two portions getting out of line, and in this position the rear portion in pushing the front portion tended to accelerate the precession. This resulted in a stabilising couple being produced by the action of the gyroscope. Professor S. M. Dixon exhibited cement-spraying apparatus and a stucco gun. The former throws cement mortar by a jet of compressed air, the mixture being blown through a rubber tube without a nozzle. In the model shown 200 cub. ft. of air at a pressure of 3½ atmospheres were required per minute, one cubic yard of mortar per hour being deposited. The stucco gun was arranged to throw cement mortar by means of a paddle driven by an electric motor. The Research Department, Woolwich, demonstrated the apparatus employed for spark photography of bullets in flight, to which we referred when dealing with the exhibits at the Royal Society Soirée, in our issue of May 22 last.

GOB FIRES.

WHEN an underground fire is started in a colliery it is not easy to extinguish, partly from the difficulty of approaching it, and partly due to the fact that the fire will probably have taken a good hold before its discovery. It may even have extended to the bands of coal in the roof or floor on either side of the seam which is being worked. In addition to heat evolved, carbonic acid gas and carbon monoxide result from the fire, firedamp from the coal and sulphuretted hydrogen from pyrites. In collieries, an explosion of fire damp thus produced by the heat is not only possible and probable, but an explosion of coal dust, far more disastrous in extent, may follow the first explosion and wreck the whole of the roads and the mine itself, unless adequate precautions are taken.

The causes of fire may be divided into three classes, namely, accidents, ignition of fire damp, issuing in the form of a blower, where naked lights are used, and spontaneous combustion. The latter is the most frequent cause, and is the only one that needs serious investigation into its origin and possible elimination. Some seams of coal are decidedly more liable to spontaneous combustion than others; those in Scotland where spontaneous heating is liable to occur are in the Fifeshire coalfield, Edinburgh district, and Lanarkshire. In the English northern division, instances are extremely rare, and although the mines are fiery or "gassy" only a few cases have been reported. In the Midland division, many collieries in Derbyshire, Nottingham, and most of the newer deep collieries in South Yorkshire working the Barnsley bed, are liable to gob fires, and the most disastrous explosion in this country due to this cause occurred at Cadeby Main, where 88 men were killed. A few of the mines of Lancashire and South Wales are also liable to gob fires, and in the Staffordshire district spontaneous combustion and fires are frequent.

The first signs of gob fire are given by a peculiar smell, termed "fire stink," followed by mist, smoke, and carbon-monoxide gas, of which a proportion as small as 0·5 per cent. is fatal. This undesirable state of affairs is produced by three agencies: first, oxidation of the organic constituents of the coal; secondly, iron pyrites; and thirdly, pressure. The first is undoubtedly the most important, but is assisted materially by the latter two. Experiments have proved that coal absorbs oxygen, one part of which combines with the carbon and hydrogen forming carbonic-acid gas and water, while the other enters into combination with the coal and proportionately increases its weight. Heating results from the absorption of oxygen, and absorption is favoured by heat, moisture, fine division, and absence of light; these thus combine to favour decomposition. Small coal does not absorb a greater amount of oxygen than large coal, but it does so more rapidly, more exposed surfaces being presented; hence crushed pillars are liable to fire. Iron pyrites, on decomposition, yield ferrous sulphate and ferric sulphate, and these products may suffer decomposition, and as their volume exceeds that of the original pyrites, disintegration of the coal is effected together with local heating in close proximity to each lump of pyrites. The oxidation of iron pyrites cannot be looked upon as the primary agent in producing combustion, as the amount of heat that would be given out by the oxidation of the quantity of sulphur in any coal can easily be estimated, but the decomposition of the pyrites, owing to the disintegration of coal produced, assists spontaneous combustion.

In mines liable to fire, a vigorous current of air must be circulated through the workings, cooling the coal surface over which it passes, and on heating being noticed, the air supply should be continued as its reduction increases the risk of fire. If reduced to a small volume, the air gets heated higher than the surrounding strata, and consequently aids rather then impedes the risk of fire. The point at which a strong current of air should be reduced is when combustion has actually broken out, but until that point is reached, a diminution is detrimental. When combustion, "gob fire," has commenced, the only thing that can be done is to drown it out if sufficient water is available and if the nature of the slope and surrounding face is suitable for this treatment, but the moist coal is liable to fire again, when the water is withdrawn. Another method is to dig the fire out, the hot material being filled into steel tubs or corves, slacked with water, taken to the pit head and tipped. The only other course is to stop off the fire by putting in strong brickwork well let into the strata to prevent leakage round the ends and top.

This last resource is attended with danger when gas is being given off in close proximity to the fire. A memorandum on the subject submitted to the Council of the Institution of Mining Engineers by a special committee, has been ordered to be issued to the Federated Institutes for discussion. This is referred to elsewhere in this issue, in our report of the Cardiff meeting of the Institution held this week. The Committee point out that when the ventilation is shut off in a gassy district, the percentage of methane in the air will rapidly increase. At the same time, the percentage of oxygen still present in the air will diminish owing to the absorption of oxygen by the coal, and by any other oxidisable material present. As soon as the percentage of methane exceeds 5·4, the air becomes inflammable if none of the oxygen has been absorbed. On the other hand, an upper limit of inflammability is reached when the methane percentage reaches about 15 if no oxygen has been absorbed. If, however,

a good proportion of oxygen has been absorbed, this upper limit is correspondingly lowered and may be as low as 12·4 per cent. These figures were accurately determined by Professor R. V. Wheeler in 1920. The percentage of 5·4 is higher, while 15 per cent. is somewhat lower, than might be expected. Where little gas is given off, the oxygen percentage will probably fall to 12·4 before the methane rises to 6·5, but in a gassy seam it seems hardly possible to avoid the risk of a gas explosion during the critical period of stopping off.

To minimise the risk of a gas explosion extending to a coal-dust explosion, the surrounding roads should be heavily covered with stone dust, and the proportion of stone to coal dust should be raised much above the statutory limit of 50 per cent. Provided that the ground has been well prepared with stone dust and damped, there is not much danger from the occasional small explosions or puffs. The sites for the stoppings should be carefully selected and the ventilation modified, and all men not engaged in the actual stopping-off should be withdrawn while the operation takes place. Fresh air should be supplied to the return stopping as well as at the in-bye side, so that in case of the first stopping being blown out, the effects will be minimised. In the second place, stoppings, so constructed that free air passages sufficient to reduce to a harmless percentage the gas in the workings of the section which is to be sealed off, should be left open to the last moment, and should then be quickly closed. The men should be withdrawn for one to 24 hours, according to the area shut off, before examination is made of the stoppings, which, if then satisfactory, can be made up permanently. To avoid leakage on both sides of the stopping, the ventilation should be so regulated that the pressure is kept even, so that there is little or no pressure to drive air through the intake stoppings. It is desirable that pipes should be left in the stoppings in order that samples of the gases may be drawn from time to time and the temperatures of the stopped-off area ascertained.

For the prevention of gob fires, the only safe method would appear to be to drive out to the boundary and work home, leaving the whole of the goaf behind, and this is being done, to a modified extent, in the Parkgate seam in South Yorkshire, but in the case of a new colliery it would necessitate a large initial outlay and a considerable length of time would elapse before any of the coal could be won. A further preventive is the removal of the whole of the coal and slack, but the intrinsic value of the coal depends chiefly on the size of the lumps, and the small, or slack, is of much less value and so is often left behind in working. With the modern tendency to use pulverised coal under boilers, however, a demand may develop for this slack. As the working face moves forward, the whole of the timber used for the support of the roof should be removed, as the goaf where timber is left is more liable to fire, partly on account of uneven subsidence and air spaces left, and partly because the timber itself is liable to heat. Steel props have been used, but are found to be very expensive compared with timber, and in working do not give the same warning of excessive weight or liability to crush. A further help is to keep the workings advancing rapidly and evenly and to exclude the air from the goaf by good packing.

LAUNCH OF THE SS. "PRINCESSE MARIE JOSÉ."—The Princesse Marie José, a sister ship of the Koningin Elizabeth, which we described on page 751 of our issue for June 12, was recently launched at the Wallsend shipyard of Messrs. Swan, Hunter and Wigham Richardson,

THE SURVEYORS' INSTITUTION.—The arrangements for the annual summer meeting, to be held jointly with the Land Agents' Society, in Liverpool, from June 24 to June 27, comprise visits on the 25th inst. to the Cathedral, the River Mersey Docks, and the City housing and town planning undertakings. By the courtesy of the Cunard Steamship Company, Limited, an opportunity will be offered of viewing the Caronia, one of the largest and most up to date of the Atlantic liners. On June 26, three separate excursions have been arranged, namely, to Knowsley Hall and Sefton Park, the seats of the Earl of Derby and the Earl of Sefton, respectively; to Port Sunlight, by kind permission of Lord Leverhulme; and to Haigh Hall, the seat of the Earl of Crauford and Balcarres, Rivington Waterworks and Smithills Hall, the seat of Colonel R. H. Ainsworth.

NOTES.

THE QUEEN MARY RESERVOIR OF THE METROPOLITAN WATER BOARD.

The inauguration of the new reservoir of the Metropolitan Water Board at Littleton in the Thames Valley was carried out on Saturday last by His Majesty the King, who was accompanied by the Queen, under practically ideal conditions in all respects. After inspecting the intake works and pumping station, the royal party proceeded to a pavilion erected on the reservoir embankment, whence His Majesty signalled to the pumping station for the pumps to be set in motion. All four pumps were then started up, delivering water into the reservoir, the capacity of which is alone sufficient to maintain a full supply of water in the Greater London area for about a month. It will thus remove all danger of water shortage under the severest drought conditions for many years to come. We have already illustrated and described the engineering features of the work in considerable detail on pages 593, 627, and 690 *ante* and also on pages 481 and 689 of our 114th volume, so that we need not deal further with them here. We may, however, mention the fact, referred to in the address read by the Chairman of the Board, Mr. C. G. Musgrave, J.P., in the course of the inauguration ceremony, that the construction of the new reservoir, including the buildings, machinery, conduits, &c., will involve a capital expenditure of 2,145,364*l.* In replying to this address, His Majesty said it was a remarkable indication of the increasing need for a copious supply of pure water to the Metropolis that a new reservoir, double the size of that at Chingford which he had inaugurated in 1913, should have become necessary. He fully realised the heavy responsibilities of the Board in carrying out their statutory duties, of the magnitude of which the occasion was a fitting reminder. At the conclusion of his reply, and as the water entered the reservoir, His Majesty named it the Queen Mary Reservoir, by which name it will be known in future. During the course of the ceremony, the chief officials of the Water Board, including Mr. H. E. Stilgoe, Chief Engineer, and Mr. T. C. Deverill, Resident Engineer during construction of the reservoir, were presented to the King, as also were representatives of the contractors and sub-contractors and some of their workers. Of the contractors' representatives we may mention Sir Frederick Hopkinson, of Messrs. S. Pearson and Son (Contracting Department), Limited, Mr. T. C. Pulman, of Messrs. Worthington-Simpson, Limited, Mr. J. W. Laing, of Messrs. John Laing and Son, Limited, and Mr. H. J. S. Mackay, of the Stirling Boiler Company, Limited.

NEW NILE DAMS.

The Egyptian Government has decided to proceed at once with the construction of a new impounding dam on the White Nile at Gebel Aulia, which is about 45 km. upstream of Khartoum, and a subsidiary, but nearly as costly, a work at Nag Hamadi, which is situated on the main Nile between the Assuan Dam and the Assiout barrage, being about 110 miles upstream from the latter. The importance of the new works may be gauged from the fact that, whilst the great Assuan Dam as now heightened retains 1,600 million cub. m. of water, the Gebel Aulia Dam will at its designed storage level impound from 3,800 million cub. m. to 5,700 million cub. m., according to the state of the river, and in exceptional floods may hold back as much as 12,000 million gallons. On the average, 4,000 million cub. m. will be added to the summer supply which passes Khartoum. It will be for the main part a solid masonry structure, but provision is made in the deepest section for large sluices similar to those adopted at Assuan, and on one side it will be continued along some high ground as an earthen dam with a masonry core wall. The total length will be 5 km., and the maximum height above foundation level will be 17 m. Provision is made for a lock 80 m. long by 14 m. wide. The height, it will be seen, is moderate, and the vastness of the storage effected is due to the character of the river valley upstream. The total length of the reservoir formed will be over 300 miles. A very large addition will be made to the area of irrigated lands in Egypt, but the construction of the dam will also lead to a reduction in the period during which the high flood lasts in Egypt, where enormous damage may arise if the peak of the flood is long maintained. This flood is in the main due to the water brought down by the Blue Nile, which has a somewhat steep bed down which floods pass quickly, carrying their silt with them. The presence of this silt makes it impossible to reduce the period of dangerous high water in Egypt by impounding either the flood on the main Nile or on the Blue Nile, owing to silting troubles. Thus the new Sennar Dam will only impound the tail of the flood. The White Nile, on the other hand, is a slow-moving and relatively shallow, clear water stream. As matters now stand its waters are ponded up when the Blue Nile flood arrives at the junction of the two streams and this ponded water, when it ultimately flows off, helps to prolong the period of high wate in Lower Egypt. By the construction of the Gebel Aulia dam this will no longer occur. The cost of the work is estimated at about 3,000,000*l.* The Nag Hamadi barrage is estimated to cost 2,250,000*l.*, and will be used to convert a large area from the basin to the perennial system of irrigation. It will also make it possible to supply "red" or silty water to areas which now receive only "white" water.

THE INSTITUTION OF ELECTRICAL ENGINEERS; SUMMER MEETING.

(*Concluded from page* 743.)

IN our article of last week we brought our account of the proceedings of the Summer Meeting of the Institution of Electrical Engineers down to noon on Tuesday the 9th inst., when the visit to the Nechells Power Station was concluded. This visit was followed by a lunch given by the General Electric Company at their Witton works, which are situated at no great distance from Nechells. After the luncheon, at which the party was welcomed by Sir Hugo Hurst, Bart., the afternoon was spent in an inspection of the works. As is generally known, the series of factories which form the Witton works of the General Electric Company, Limited, represent but one item in the remarkable manufacturing organisation, which has been built up in some 40 years, mainly by the ability and enterprise of Sir Hugo. The General Electric Company, Limited, now claims to be the largest electrical manufacturing organisation in the British Empire, and operates not only the Witton works, which in themselves include many separate factories manufacturing electrical machines of all sizes, switchgear, transformers, batteries, arc lamp carbons, &c., but also works at Erith, Southampton, Manchester, Birmingham, Hammersmith, Lemington-on-Tyne and Wembley.

An adequate description of the Witton shops is quite impossible in the space now at our disposal, but any account we are able to give may be supplemented by reference to an illustrated description, which we published about three years ago.*

The Witton works include the carbon and moulded insulation factories and lamp-black works, while electric tools and small motors and fans are also made there; in spite of these exceptions, however, it is, we think, not incorrect to say that the chief concern of this particular branch of the General Electric Company's organisation is with industrial and heavy electrical plant. The largest individual machines which are constructed form, of course, the electrical ends of turbo-alternator sets, and as mentioned in our article of last week, three machines of 22,500 kv.-a. capacity for the Nechells station were to be seen in process of manufacture in the works. A very fine collection of machine tools has been got together for dealing with the stator and rotor machining for such alternators. These include a lathe, which is chiefly used for rough turning the rotor forgings, capable of taking a job 26 ft. long between centres and of 56 in. diameter. Another fine machine is a large plano-milling machine used for slotting the solid rotors, which are always used by the company

* See ENGINEERING, vol. cxiii, page 166 (February 10, 1922).

for their turbo-alternators. A large boring mill for stator shells may also be mentioned. This can accommodate work 12 ft. 6in. in diameter and has an effective boring depth of 9 ft. 6 in.

In addition to the Nechell's machines the works contained many turbo-alternators in course of construction, including two of 12,500 kv.-a., and 3,000 r.p.m., for the Sunderland Corporation. A very large number of motors of various classes Similar motors were to be seen in process of manufacture in the works, while direct-current traction motors, forming part of a large contract for the London Electric Railway, were also to be seen, as well as a number of tramway motors.

The switchgear works at Witton form a manufacturing unit of which the company have much reason to be proud. This is an independent building 400 ft. long by 250 ft. wide, exclusive of offices and

FIG. 3. EXTRUDING PRESSES FOR LAMP CARBONS; THE GENERAL ELECTRIC COMPANY, LTD.

FIG. 4. OVENS FOR LAMP CARBONS; THE GENERAL ELECTRIC COMPANY, LTD.

was to be seen in the appropriate shops, including a reversible rolling mill motor of 18,000 h.p., which has been built for Messrs. Baldwins, Limited, of Swansea. Another interesting feature was the large number of traction motors for both alternating and direct-current in process of completion. The General Electric Company began the manufacture of traction motors comparatively recently, but this particular branch of electrical manufacture has been entered into with characteristic energy, and a large number of coaches equipped with G.E.C. motors has recently been put to work on the Brighton section of the Southern Railway. auxiliary buildings, and forms an admirable example of a modern factory building designed from the first for the manufacture of a particular type of product. The shops are divided into five main bays which are respectively devoted to switchboard erection, starter and controller assembly, stores, machine work and assembly of ironclad gear and process shops. Switchgear necessarily consists of an assemblage of a very large number of small parts and the stores, which are of unusual capacity, form an important section of the factory. They run practically the whole length of the works down the centre and are easily accessible to all employees. The switch and control gear manufactured in this works we cannot now deal with. Many items in the large range of manufacture which extends from starting gear for small motors to main switchgear up to any voltage or capacity, we have dealt with in the past, and may especially mention our description of the 33,000-volt gear at Gorseinon, which appeared in our issues of February 29 and March 7, 1924.

While it is impossible for us to deal with more of the purely engineering shops of the Witton works at the present time, in view of its unique character, we would like to say something of the Carbon Works. As is probably generally known these are the only works of this class in the country and rendered very valuable service during the war. Before that event the combined demands from the Admiralty and War Office for searchlight carbons amounted to 150,000 per annum, while during the period of hostilities the works provided 5,000,000 searchlight carbons, and approximately 7,000,000 arc lamp carbons for dock and yard lighting and similar purposes. In the latter part of the war some half million searchlight carbons were supplied to Allied Governments.

Searchlight and arc-lamp carbons are made essentially from coke and lamp black with a tar binder. For good results great attention has to be given to the raw material, and a lampblack factory has been built at Witton to ensure adequate supplies of good quality. The coke is ground to a very fine powder and is mixed with a proportion of lamp black which varies in accordance with the quality of the carbon being made. Tar is then added to the mass and the mixing process is continued. Leaving the mixers the material is passed through calenders with heavy steam-heated rolls. This ensures the tar being thoroughly worked into the powder. After leaving the calenders the material is stamped into cylindrical blocks or cheeses, these being taken while still warm to hydraulic presses by which the carbons are forced out through dies to the sizes required. A view of the press shop is given in Fig. 3, herewith. The extruded carbon rods are then bundled preparatory to being placed in crucibles for baking. This process, which is carried out in the ovens, shown in Fig. 4, takes from five to seven days, the highest temperature reached during the operation being from 1,400 deg. C. to 1,500 deg. C. During the baking process the carbons lose their plastic nature and come out of the ovens in a hard and brittle condition. They are at this stage cut to length and sorted and then passed through automatic machines, which flatten and point the ends and finish the carbons accurately to length. With solid carbons this operation completes the manufacture, but with cored carbons the core material has to be squirted in after which the rods are dried in an oven at 150 deg. C. In addition to lamp carbons of various types, carbon battery plates are also manufactured in these works.

In the evening of this day a reception was held at the Council House by the Lord Mayor of Birmingham, the City Art Galleries being open for inspection by the visitors.

The morning of Wednesday, the 10th inst., was occupied by a visit to the works of the Austin Motor Company, Limited, at Longbridge, and to one of the mercury-arc rectifier sub-stations of the Birmingham Corporation, to which reference was made last week. The party was entertained to lunch at Droitwich by the Shropshire, Worcestershire and Staffordshire Electric Power Company, and afterwards inspected this company's new station at Stourport. The evening was spent at a reception and dance at the University, given by the Council and Senate. It will be realised that this programme involved a considerable amount of travelling, which was made by motor coach. The arrangement of the following days involved similar road travel, and an excellent opportunity was afforded of seeing the main roads out of Birmingham to the west, south and east. The striking feature of these roads was the very large amount of important widening work in hand. In general it appeared that a somewhat greater width than that of the new outer roads in the London district is being adopted. An opportunity was also furnished by this road travel of seeing something of the heavy railless traction which has

been inaugurated in Birmingham. One of the busy suburban routes, the track of which had seriously deteriorated during the war, has been converted to railless traction. Double-decked cars with covered tops are used, and do not differ greatly in appearance from tramcars. The experiment has been very successful, the revenue per mile run of the trolley 'buses working out at 18*d.*, as compared with 18·2*d.* for trams and 15·6*d.* for petrol 'buses. The corresponding costs for the three services are: 12·15*d.*, 12·7*d.* and 11·9*d.* The petrol 'buses in Birmingham are apparently mostly provided with covered tops, a construction which is, as yet, not allowed for two-deck 'buses in London.

In dealing with the proceedings of Wednesday, we are afraid that no attempt can be made to describe the Longbridge Works of the Austin Motor Company. An adequate description of this extensive establishment would require both illustrations and much space, for neither of which we have space at the moment. The company was formed in 1905, at which date the works covered 2½ acres. At present they occupy 62 acres. As will be generally known, very extensive additions were made to the manufacturing capacity during the war, and at the peak the total number of employees was 22,000. In 1905, 270 hands were employed, while the present figure is over 8,000. The present annual production is 16,000 cars. The firm also builds lorries, tractors and electric lighting sets.

The Stourport station of the Shropshire, Worcestershire and Staffordshire Electric Power Company, which was visited during the afternoon, is designed to form one of the three capital stations of the South-West Midlands Electricity District, as we mentioned last week. The station is still under construction, but some of the boilers are in place and the first turbo-alternator stator is being wound on site. The station is to have an ultimate capacity of 105,000 kw., and the initial installation is to consist of two 15,000-kw. turbo-alternator sets, which are being supplied by the British Thomson-Houston Company, Limited, of Rugby. Messrs. Cole, Marchent and Morley of Bradford are supplying the main condensers. The initial boiler installation, for which Messrs. Babcock and Wilcox are acting as main contractors, consists of four Stirling boilers, each designed for a normal capacity of 60,000 lb. per hour and an overload capacity of 100,000 lb. per hour, the working pressure being 350 lb. per square inch and the final temperature 725 deg. F. The valves and steam fittings are being supplied by Messrs. J. Hopkinson and Co., Limited, of Huddersfield. The station is situated on the right bank of the River Severn immediately south of its confluence with the River Stour. The site proved an excellent one for building, sandstone rock being found 13 ft. to 16 ft. below the surface of the ground. The condensing water and coal supply facilities are good. The station is situated 60 miles from Sharpness Docks, and the river is navigable up to the station by 150-ton barges, while coal may also be brought to the station by the Staffordshire and Worcestershire Canal and by the Great Western Railway. The condensing water available from the Severn is estimated at 240 million gallons a day as a minimum.

The Shropshire, Worcestershire and Staffordshire Electric Power Company has at the present time four power stations in operation. These are situated respectively at Smethwick, Dudley, Kidderminster and Redditch. These stations will ultimately be shut down when the new main power station scheme is in operation. The company now supplies over a large area and covers the towns of Halesowen, Dudley, Kidderminster, Redditch, Bromsgrove, Droitwich and Upton-on-Severn. An application is now before the Electricity Commissioners for an extended area in the Avon Valley. The company has shown much enterprise in the development of electricity supply in rural districts, and there are now many hundreds of consumers in small towns and isolated villages. Some of the company's present stations operate a direct-current system, while Redditch operates at 50 periods. The new Stourport station will, however, generate at 25 periods to maintain uniformity with the Birmingham area, with which it will be interconnected, and the alternators now under construction are being wound for this periodicity. If anything is really to come of the Government's scheme for standardising periodicity at 50 for the whole country, it is clear that the sooner it comes the better. Both in generating plant and consumers' installations this progressive district is becoming every day further committed to 25 periods.

The main item of technical interest in the proceedings of Thursday, June 11, was a visit to the works of the British Thomson-Houston Company at Rugby, although very great interest and success attached to the visit to Warwick Castle and to the dance and cabaret entertainment which had been arranged for the evening at the Magnet Club, Witton, by the General Electric Company. This last function was a brilliant one, and although a description of the proceedings hardly lies within the scope of our pages, mention must be made of the remarkable lighting effects which had been arranged in the ball-room. Lighting fittings of all kinds are, of course, among the almost inexhaustible list of manufactures of the General Electric Company and the technical knowledge of the company had certainly been employed to good effect in arranging this display which was both brilliant and pleasing. Before leaving the social features of this day we should say that tea was provided in connection with the Warwick Castle visit by the Leicestershire and Warwickshire Electric Power Company, the Midland Electric Light and Power Company, and the Leamington and Warwick Electric Company.

FIG. 5. THE FOUNDRY; THE BRITISH THOMSON-HOUSTON COMPANY.

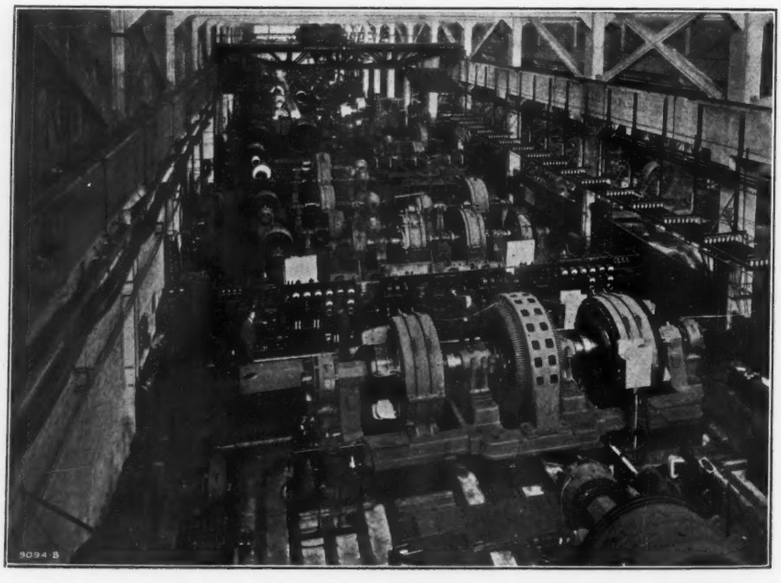


FIG. 6. MOTOR GENERATOR SHOP; THE BRITISH THOMSON-HOUSTON COMPANY.

In attempting some description of the Rugby works of the British Thomson-Houston Company we experience again the difficulty of doing any proper justice to our subject within the limits of this account of a Summer Meeting. The works occupy an area of over 90 acres, and although they are on the site of the company's original factories, continuous growth of business has resulted in various

classes of work being removed to other centres. Thus switchgear is now manufactured at the firm's Willesden works, standard motors and small and medium-sized generators at the Birmingham works, magnetos and radio apparatus at Coventry, and glass for Mazda lamps and B.T.H. radio valves at Chesterfield. The whole of the factories of the company cover an area of 200 acres and employ 11,000 persons. The Rugby factory forms an excellent example of a modern engineering works and is self-contained with its own power station and foundry. The Mazda lamps works form an independent part of the factory and occupy their own buildings. The power station contains 4,000 kw. of generating plant, but like the generating equipment of many other successful works has proved of insufficient capacity to cope with all extensions, and additional supplies are obtained from the mains of the Warwickshire and Leicestershire Electric Power Company.

The factory has its own foundry which, as will be gathered from the view given in Fig. 5 opposite, is a very fine shop. The equipment allows of the production of castings up to 100 tons weight and all the firm's heavy turbine and similar castings are produced in it. Part of the building consists of three floors, the upper stories being devoted to the production of small castings for which machine moulding is employed to a very considerable extent. Among the heavy machine shops the turbine shop may be first mentioned. This is 1,000 ft. long and 270 ft. wide and contains a fine equipment of heavy machine tools, which includes a very large floor plate with an installation of movable tools. The assembly of turbo-generators is carried out at the north end of the main bay, which is equipped with two machines for dynamic balancing tests, one of which is capable of balancing rotors up to 2 tons in weight and the other rotors up to 20 tons weight. The testing of completed machines is carried out on a plant provided with condensers capable of dealing with 35,000 to 40,000 lb. of steam per hour. High and low pressure steam supplies are available at pressures up to 250 lb. per square inch, and any required superheat up to 750 deg. F. can be obtained by means of a separately fired superheater.

Next to the turbine department there is another 1,000-ft. shop in which large motors, rotary converters, motor converters and motor generators are manufactured. A part of this shop with a 2,000 kw. synchronous motor-generator set on test is shown in the view given in Fig. 6 opposite. Much interesting plant is built in this shop and a large Ward-Leonard Ilgner winder for the Bolsover Colliery Company was to be seen at the time of the visit. Two of these plants have been completed and will form part of the equipment of a new colliery now being sunk in the Sherwood Forest district. Each motor will give a continuous output of 2,160 h.p. Another large winder recently manufactured by the British Thomson-Houston Company for South Africa has a capacity of 2,160 h.p. on continuous rating and is believed by the company to be the largest geared induction motor winder in the world. Also adjoining the turbine department there is a machine shop for traction motors and medium sized generators and motors which are above the capacity of those dealt with at the Birmingham works.

Among the other shops forming part of the Rugby works there is an interesting one concerned with the manufacture of automatic and non-automatic equipments, including the company's well-known automatic sub-station gear. Switchgear proper is built at the Willesden works, but this special equipment is made in the shops with which we are now concerned. The automatic sub-station equipments so far built by the company range in single units from 250 to 4,500 kw. at 400 to 3,000 volts D.C. and comprise single rotary converters, two rotary converters in series and synchronous motor-generator sets. Another very interesting shop which, however, is perhaps somewhat outside the main manufacturing activities of the firm is the apprentice department, which includes a fully equipped workshop engaged on production work. The firm, in common with some others, has three courses of apprenticeship training covering trade apprentices, engineering apprentices and student apprentices, and much attention has been given to an effective shop education from each group.

The final day of the meeting, Friday, June 12, was spent on an excursion to Stratford-on-Avon and Evesham. At the latter town the party was entertained to lunch and tea by the City of Birmingham Electric Supply Department. A reception by the President at the Botanical Gardens, Edgbaston, was held in the evening and formed the final item in a very successful meeting. Throughout all four days the weather was perfect and all arrangements worked excellently. Much credit attaches to the local committee which organised the meeting and to the Secretary and staff of the Institution. The same remark applies to the various firms and public bodies which entertained the Institution or made arrangements for visits.

VOCATIONAL GUIDANCE.

THE Industrial Fatigue Research Board has recently published a report by Miss Frances Gaw, on "Performance Tests of Intelligence," [Report No. 31, H.M. Stationery Office, 2*s.* 6*d.* net], which describes a number of such tests applied in three elementary schools of the London County Council. The use of performance tests appears to date from work done in the earlier half of the last century in the education of a boy who was found running wild in a French forest, and in the training of defectives; but in more recent times such tests have been found indispensable in America, where discrimination has been required between non-English-speaking foreigners, and linguistic tests, whether oral or written, were, therefore, inapplicable. The present small series illustrates part of the work that is going on in this country in the endeavour to promote vocational guidance. No efforts can be more praiseworthy and of greater national advantage than any which might lead to reducing the number of round men who find themselves in square holes. These efforts are being made for the most part by or under the supervision of men distinguished in the modern science of psychology.

The present report, with a wealth of references to psychological journals and descriptions that is sufficient to enable a lay reader to follow it, does not appear to be an esoteric address to psychologists. It has been noticed in the daily Press, and may be assumed to be addressed to those who are interested as much in the results sought as in the methods used. It is no disparagement of the great value that may be hoped from investigations or methods of vocational guidance to say that the condition of their being useful is that they shall be adequately calibrated. So far as the present report throws light on the point, there seems to be a tendency to calibrate one set of tests by reference to another, without the doubtless time-consuming but indispensably necessary reference to practical conditions. If it may be said without disrespect, this is a sort of scientific long-firm procedure, than which nothing can be either further from the intention of the distinguished men associated with the difficult task in question, and of those who practise the available methods, or less calculated to lead to the permanent results they have in view.

MERCURY-ARC RECTIFIER DEVELOPMENTS.—That the mercury-arc rectifier forms an efficient and convenient means of transforming alternating-currents into direct-currents, particularly for supplying high-tension direct-current traction systems, is indicated by the fact that a considerable number of these appliances have been ordered for the purpose during recent months. The rectifiers, which were illustrated and described on pages 507 and 543 of our 116th volume, have been developed by Messrs. Brown, Boveri and Co., and are marketed in this country by Power Rectifiers, Ltd., Trafalgar House, Waterloo-place, London, S.W.1. Of the recent orders we may mention four 1,500 kw. sets supplying direct current at 1,500 volts for the Illinois Central Railroad Company, Chicago, and fifteen 1,000 kw. sets for the electrification of Dutch lines between Rotterdam and Amsterdam. We also understand that the Ford Motor Company, of Detroit, who have had a rectifier plant in operation since 1923, have placed a repeat order for two 1,000 kw. sets supplying direct current at 460 volts for power purposes.

THE LATE MR. SAMUEL MECHAN.

THE death occurred at a nursing home in London, on Tuesday, June 9, of Mr. Samuel Mechan, one of the joint managing directors of Messrs. Mechans, Limited, of Scotstoun Iron Works, Glasgow. Mr. Mechan was educated at the Glasgow High School and at the Royal Technical College, Glasgow, and served his apprenticeship with the firm which his father founded in 1862. The nature of the manufactures of the firm, nitrate and gold-mining plants, oil storage tanks, &c., necessitates frequent visits of a member of the firm to many parts of North and South America, Australia, Africa, and the Continent of Europe, and it was on this side of the company's activity that the services of Mr. Mechan proved of great value to the organisation. He was the possessor of many social qualities, which endeared him to all who came into touch with him, and his loss will be greatly regretted by engineers in every part of the wide field in which the firm had business relations.

Mr. Mechan had to undergo a serious operation some two years ago and since then had not enjoyed good health, although he carried on much of his usual activity. When on a business trip to America recently, he was taken ill in New York and, persisting in his determination to come home, he was brought to London and an operation was performed on him shortly after arrival. Though this proved successful, Mr. Mechan lacked the strength to recuperate, and he gradually weakened until his final collapse.

THE FARADAY SOCIETY.—A meeting of the Faraday Society taking the form of a general discussion on "Photochemical Reactions in Liquids and Gases," will be held at Oxford on October 1 and 2. The subject will be discussed under two main heads. (1) Einstein's Law of Photochemical Equivalence. (2) The Mechanism of Photochemical Reactions. The first part will be opened by Professor A. J. Allmand, King's College, and the second by Professor M. Bodenstein, Berlin. Many distinguished English and foreign investigators on photochemical action will take part in the proceedings, and an attractive programme of papers has been arranged and will shortly be issued. It is hoped to accommodate all who attend the meeting at Exeter College and Lincoln College. Non-members of the Faraday Society desirous of attending the meeting are asked to communicate at once with the Secretary of the Faraday Society, 90, Great Russell-street, London, W.C.1, from whom full particulars may be obtained.

MOTOR LIFEBOAT "MILBURN."—The new motor lifeboat which the Royal National Lifeboat Institution has built for use at Holy Island in Northumberland, reached her station recently. She is of the latest type, a Watson lifeboat with a cabin, and is 45 ft. long and 12 ft. 6 in. broad. She has an 80 h.p. engine, is fitted with a searchlight and a line throwing gun, and has 130 airtight cases, the latter rendering her practically unsinkable. The first boat of this type was completed in 1923, and is stationed at Tenby in Wales. The new lifeboat for Holy Island, the cost of which is approximately 8,000*l.*, has been built out of a legacy received from the late Sir Charles Stamp Milburn, supplemented by a gift from Mr. Frederick Milburn. Her name will be Milburn. The institution has now 53 motor lifeboats in its fleet of 220 lifeboats. Holy Island is one of the oldest stations on the coast, having been established in 1829, only five years after the founding of the institution itself, and has the record of 228 lives rescued from shipwreck.

LAUNCH OF THE MOTOR TANKER "BRITISH PETROL."—Recently Messrs. Swan, Hunter and Wigham Richardson, Limited, launched from their Neptune Works, Newcastle-on-Tyne, the single-screw steel motor tank ship British Petrol which they are building to the order of the British Tanker Company, Limited, of London. This is a sister ship to the British Motorist, lately built for the same firm at these works, and is being constructed for the carriage of oil in bulk. The vessels are 454 ft. in length and 57 ft. in breadth, and are intended to fulfill the requirements of the highest class in Lloyd's Register. About 10,100 tons total deadweight will be carried on a draught of 26 ft. 8 in. The oil cargo will be carried in 20 hold tanks and 10 summer tanks, whilst a hold forward will accommodate ordinary cargo. Very complete equipment for dealing with the oil cargo is provided, including two pumps, each of which is capable of discharging 300 tons per hour. Deck machinery to be supplied will include a steam windlass, four steam winches and electrically driven steering gear of the Hele-Shaw type. The propelling machinery consists of a set of the builders' internal-combustion engines of the Neptune type operating on the two-cycle, single-acting, system with port scavenging. Eight cylinders having diameters of 24 in. and a stroke of 50 in., will develop 3,200 brake horse-power. Two marine type steam boilers are installed, these being required to supply steam for the cargo oil pumps and certain of the engine room auxiliaries. Electric power is supplied by two 60 kw. generators supplied by the Metropolitan-Vickers Electrical Company, Limited, driven by two 90 brake horse-power Atlas Diesel engines. Arrangements are made by which the main engine exhaust can be passed through one of the boilers to generate steam.

LABOUR NOTES.

THE representatives of the executive councils of the engineering trade unions are to meet in London to-day for the purpose of considering the employers' latest communication regarding the state of the industry. Hitherto they have pressed the demand for an advance of wages, and declined to consider in joint conference with the employers how economic buoyancy might be restored to the industry. At present, the industry cannot bear even the labour costs which it is expected to bear, and the employers, in the letter which the unions are now to consider, definitely state that an increase in wages without compensatory conditions is impracticable. That disposes of the wages issue as it has been raised by the unions, and to that extent the position may not unreasonably be regarded as critical. The unions may now do one of two things. They may decide to ballot their members on the wages issue, and in that way precipitate a stoppage for which they are ill prepared; or they may decide to face the facts as everybody else sees them, and endeavour, in conjunction with the employers, to give the industry the chance in foreign competition which it needs. Wage rates and working hours are, for the time being, questions of minor importance. The trouble for which a cure has to be found is that under current working conditions the industry cannot carry on for much longer. That being the case, a stoppage by the men would achieve nothing, whereas if an arrangement were arrived at on the lines of Sir Allan Smith's proposals, the industry would be put into a more favourable position relatively to the positions of foreign competitor industries, and the earning capacity of every worker would be increased. It is to be hoped that at to-day's meeting the representatives of the men will take the saner, sounder view, that questions of wage rates and working hours ought to remain in the background until the larger and much more vital question of restoring economic buoyancy to the industry is disposed of.

It is difficult to tell exactly what happened at Tuesday's meeting of the committee appointed to frame a constitution for the new industrial alliance desired by the Miners Federation, as no official account of the proceedings was issued and statements made by a number of delegates after the meeting were, to say the least, confusing. Two things, however, appear to be certain. One is that, whatever the alliance turns out to be, it will not be the trouble-precipitating organisation which the National Minority Movement desires. In plainer language, a sort of general stoppage of the unions, which are parties to the pact, in support of a miners' strike, is extremely unlikely. The other thing which is tolerably clear is that if the craft unions and the industrial unions which are represented on Mr. Cook's committee do not speedily compose their differences on the railway shopmen question, there will be no alliance of any kind. The National Union of Railwaymen has already made that plain enough, and its firm attitude merely serves to accentuate the bitterness which exists between it and the craft unions.

In the House of Commons last week, Mr. J. Beckett, the Labour member for Gateshead, asked whether the Prime Minister was considering the calling of a national industrial conference representing all employers and workers, in all trades, together with representatives of the general community, to consider the growing menace of unemployment? In a written answer, Mr. Baldwin said:—"I doubt whether a general conference of this kind would be effective for the purpose in view. I think it is important that there should first be the fullest discussion possible between all parties in individual industries on the lines of the discussions now taking place in certain of the industries in which unemployment is most severe. When these conferences have proceeded further, it will be possible to consider whether representatives of other industries can with advantage be invited to participate in the discussions."

In the latest issue of the *A.E.U. Monthly Journal*, Mr. W. Glennie, one of the assistant general secretaries, has a short article on the subject of patents in the course of which he suggests that Parliament might give a needed fillip to invention by amending the Act of 1902 and reducing the period over which search shall extend to, say, 25 years. The most fertile engineering inventors of the first half of last century were, he says, workers in the trade, or employers who had risen from the ranks, but their reward was small compared with the vast development and continuously increasing prosperity of the industry. That was due, Mr. Glennie says, principally to our faulty patent laws, which failed to secure to inventors a fair share of the fruits of their labour. To restore the engineering trade to its wonted prosperity the workers in their tens of thousands should be enlisted, he thinks, in the improvement of the means of production and also of the quality of the products themselves. Suggestion boxes and other methods are already in use in many of the workshops, but they do not always lead to an equitable distribution of the profits, and, therefore, are not a sufficient inducement to the workers to put their energies into their inventive faculties. It is probable, Mr. Glennie adds, that a simplification of the methods of obtaining a patent which would secure to the inventor a substantial reward of a lasting nature would provide the necessary stimulus in the direction indicated.

In May the home branch membership of the Amalgamated Engineering Union increased from 212,825 to 213,756 and the Colonial branch membership decreased from 25,619 to 25,604. At the end of the month the number of unemployed members was 16,331—an increase of 1,149 as compared with the previous month.

The *Monthly Report* of the United Society of Boiler Makers and Iron and Steel Shipbuilders states that at the end of May 21,033 members were "signing the books," as compared with 20,175 at the end of April. The expenses for April were 89,359*l.* 15*s.*; in May they amounted to 108,690*l.* 5*s.* 1*d.* Increases are also recorded in the number of members on superannuation benefit and also of the number of members on sick benefit. The increases are, however, according to the general secretary, accounted for by the more complete returns which have been sent in for May. Compared with two months ago when the returns from the branches were normal, the unemployment and sickness figures show a reduction. "In the first two or three years of the present slump we had," Mr. Hill goes on to say, "great reserves and we disposed of these reserves amongst our members in paying not only full benefits but considerable additional benefits, to tide our members over their time of need, believing that the trade cycle, as usual, would bring us to prosperity in a year or two; but the slump has continued and the lack of employment means not only a disbursing of benefits but a lack of contributions; and whilst, for a time, we have curtailed benefits and reduced administration costs, we may find it necessary in the near future either to make further curtailments, or to increase our income, if we are to restore our finances to the amount required by rule. Our list of members in arrears is a heavy one, and is due largely to unemployment, but where members are working it is the duty of all our officials, with the help of shop stewards and members, to see that they carry clear cards. . . . If, as a Society, we had all the money which members owe us it would make a very considerable difference in the society's finances, and it would postpone, if not altogether obviate, the need of further financial provision."

Speaking after the launch last week, at Wallsend, of the Canadian Lakes steamer *Glenledi*, Mr. Summers Hunter, managing director of the North Eastern Marine Engineering Co., Limited, said that in this country workmen belonging to from twenty to twenty-five unions, were employed in the construction of a set of Diesel engines. According to Sir George Hunter the men employed in the construction of a ship belonged to thirty trade unions. In Continental countries, Mr. Summers Hunter said, a very different state of matters prevailed. There, only six trades were employed in the building of engines. There was, consequently, much less waste of time caused by delegates going about adjusting grievances.

Interviewed regarding the placing of a fairly important repair contract with a firm in Holland, Mr. T. T. Anderson, a member of the firm of Messrs. Dent and Co., Newcastle-on-Tyne, said that there was a vital difference in the deliveries offered by British and Dutch concerns. The lowest Tyne tenders were 10,314*l.* for 52 working days, and 10,415*l.* for 53 working days. Messrs. Wilton of Rotterdam, who secured the job, quoted 9,090*l.* for 42 running days, two other Dutch firms quoting 10,000*l.* for 40 and 45 running days respectively. Prior to the war, Mr. Anderson said, he had always found that foreign owners, if they wanted a good job done quickly, sent their ships to the Tyne. On the evidence of the figures which he had given a serious change had clearly taken place. British operatives could do better work than Dutch operatives, but the latter worked under a system which kept operations going for 24-hour running days—a system which, he believed, British trade unions declined to adopt. British ship repairers were, therefore, Mr. Anderson said, at an enormous disadvantage in competition with Dutch firms.

The Ministry of Labour states that on June 8, 1925, the number of unemployed persons on the registers of Employment Exchanges in Great Britain was 1,291,200—1,009,300 men, 35,300 boys, 218,800 women and 27,800 girls. On June 1, 1925, the number was 1,247,306—971,211 men, 34,184 boys, 213,868 women and 28,043 girls—and on June 9, 1924 it was 1,027,515—764,321 men, 31,559 boys, 200,705 women and 30,930 girls.

Writing in *Foreign Affairs*, Mr. C. T. Cramp, the general industrial Secretary of the National Union of Railwaymen, and this year's chairman of the Labour Party, expresses the opinion that if the present policy on unity of some of the leaders of British trade unionism leads to severance from the Amsterdam International and adhesion to the Red International, the result will be the break up of the Trades Union Congress. "It is practically certain," he says, "that a number of large unions would secede from Congress if this step were taken, and, thus, instead of unity being promoted, greater disunity than ever would be the result." What Mr. Cramp says is in line with observations which have been made in these Notes on a closely related subject. The aim of the "Red" claimant in British labour circles—which is, of course, responsible for the "unity" movement — is to capture the General Council and, through it, Congress. It desires, in effect, to transform the Council into a General Staff with power to co-ordinate the activities of the unions affiliated to Congress and so bring about the destruction of capitalism. Obviously, however, the likelihood is greater that it will bring about its own extinction, because the average worker has no desire to smash capitalism. On the question of the General Council's powers, as well as on this question of unity, the extremists are practically certain to be left "in the air" by Congress and the affiliated unions at some stage or other of their progress towards the "revolution" of their dreams.

At a meeting in London last week of the executive councils of the various bodies affiliated to the National Allied Building Trade Employers, the position created by secession of the bricklayers' and plasterers' unions from the National Federation of Building Trade Operatives and the National Wages and Conditions Council was considered. The decision was re-affirmed to stand by the principle of national negotiations and agreements, and not to negotiate sectionally. The effect of this decision is that the unions which have seceded will have no locus standi when negotiations are in progress between the employers and the operatives' federation.

On the following day, the executives of the trade unions remaining in the National Federation of Building Trade Operatives passed this resolution:—"That this meeting of joint executive councils of the unions affiliated to the National Federation of Building Trade Operatives is convinced that the maintenance of the Federation is essential to the welfare of the building trade operatives of this country, and hereby pledges itself to remain loyal to the National Federation of Building Trade Operatives. It deplores the decision of the Amalgamated Union of Building Trade Workers and the National Plasterers' Society, and believes such action will have a serious effect upon the solidarity of the building trade operatives, and can only result in preventing the important reforms under consideration being established. It trusts that the members of these unions will reconsider their decision to isolate themselves from their fellow-workers in the industry, and hopes that such reconsideration will result in a decision again to join forces with the unions in the National Federation of Building Trade Operatives, and so enable them to present a united front."

The proposed new constitution for the National Wages and Conditions Council, drafted by the National Allied Building Trade Employers and the National Federation of Building Trade Operatives, is to be submitted to a ballot of the men. Votes are returnable, it is understood, by August 30. The agreement—which has also, of course, to be ratified by the general body of employers—continues the cost of living sliding scale, but makes its operation more favourable to the men, by reverting to the scale as it was before its modification two years ago. The working week as presented by the Fraser award is continued. Working conditions, particularly travelling time and allowances for special jobs, which under the present agreement are settled nationally, it is now proposed should be discussed and settled locally, to give freer play to local circumstances.

ROYAL AERONAUTICAL SOCIETY.—At a meeting of Council, held on June 8, 1925, Air Vice-Marshal Sir W. Sefton Brancker, K.C.B., A.F.C., was elected Chairman of Council for the period from October, 1925, to September, 1926. A memorial to those lost in the disaster to the airship R.38 (ZR 2) has been placed in the Society's library, and will be unveiled on Monday, June 29, at 4 p.m. by the American Ambassador.

THE DRAYTON STEAM METER.

CONSTRUCTED BY THE STEAM FITTINGS COMPANY, LIMITED, WEST DRAYTON, MIDDLESEX.

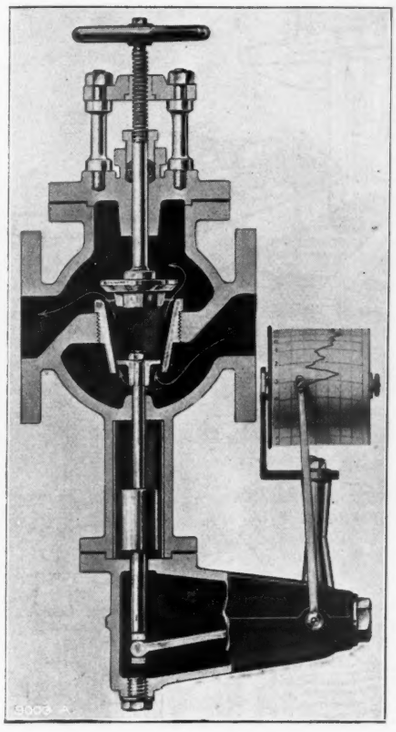
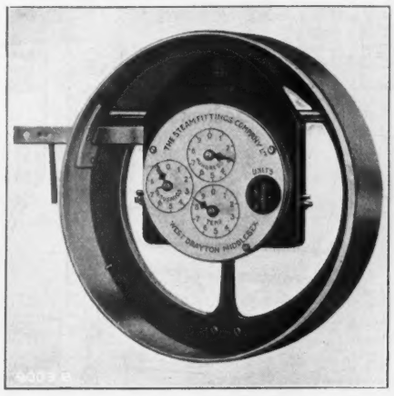


FIG. 1.



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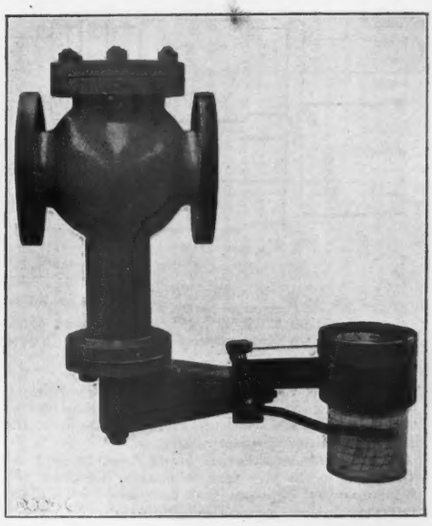

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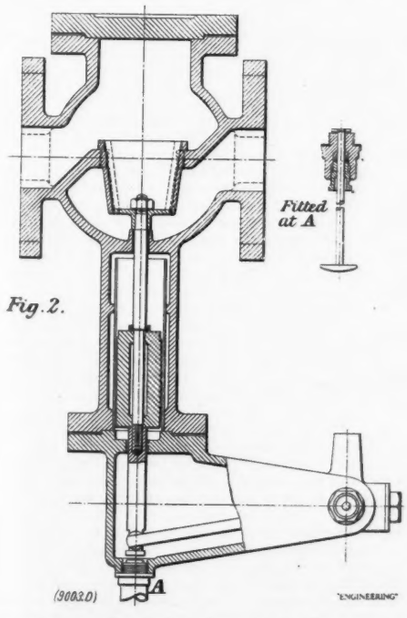

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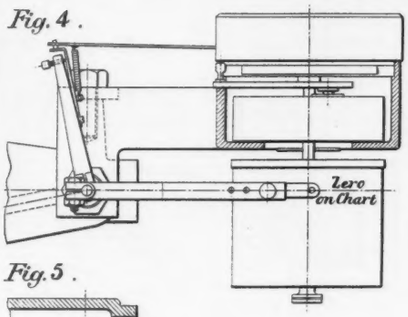

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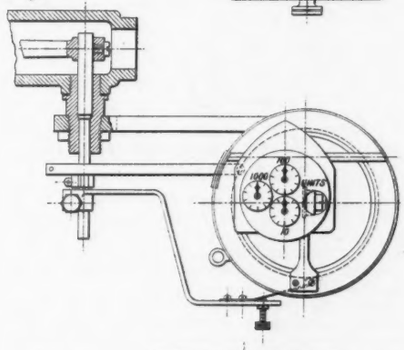

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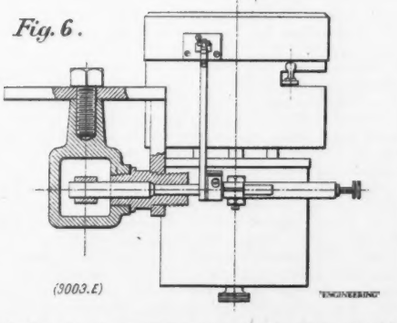

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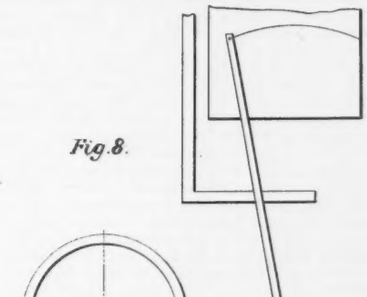

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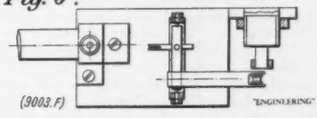


Fig. 9.

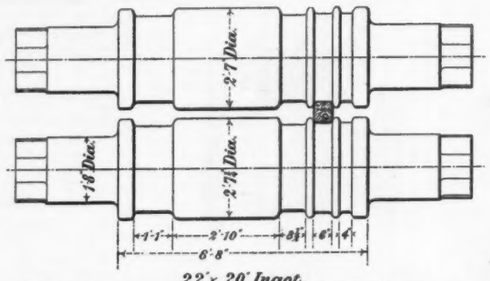
THE DRAYTON STEAM METER.

FOR long a need has been manifest for some type of steam-measuring device, which will show the instantaneous changes in the rate of flow and at the same time provide an indication of the total amount of steam that has passed since the instrument was re-set. The uses for such a device are manifold, for if dependable results may be obtained from it, the economy of working of any steam-using plant may be checked instantly, and if unexpected results are obtained, their cause may be sought right away and remedies against their continuance may then be introduced. As affording an example of a valuable contribution to this sphere of instrument design and construction, we illustrate on this page a simple type of steam flow indicator mounted in association with a valve, together with views of an integrating device introduced to obtain the summation of the total quantities of steam passed, and of the means adopted for correcting the readings for variations in steam pressure. The instrument in question is a British product made by The Steam Fittings Company, Limited, of West Drayton, Middlesex. With it a guarantee of accuracy of $\pm$ 3 per cent. is given, and as the illustrations show, the instrument may be supplied with a stop valve, or alternatively be completely independent of the steam control.

From Figs. 1 and 2 the general arrangement of the instrument may be clearly seen. The essential feature is a floating disc or plate loaded by means of a cylindrical weight, the movement of which leaves more or less opening for the passage of steam between its edge and the cone-shaped bush within which it is situated. In Fig. 1 the top part of this cone is shown employed as the seating for a stop valve. When the steam valve is opened the floating system will be raised until the small difference in pressure between top and bottom of the disc keeps it in suspension. Should now the rate of flow be changed the equilibrium would be destroyed, and the disc would settle immediately into a new position to meet the altered conditions. The weight of the disc and its loading piston being fixed, it will float when a certain constant difference of pressure exists between its two sides, and it is therefore only necessary to give the bush such a shape as will provide a continuous increase of area for steam passage, which is strictly proportionate to the lift. Since this is arranged for in the instrument the lift of the disc may be used as the measurement of the quantity of steam passing at any moment. As is seen from Figs. 1 and 2, the movement of the disc is directly transmitted through a lever and shaft to a recording pencil, which draws a graph of the disc

BRITISH ROLLING MILL PRACTICE.

Fig. 2. BLOOMING MILL ROLLS. TRUMBULL STEEL Co.



22" × 20" Ingot.
1st 2nd 3rd 4th Passes on Centre Barrel, 5th 6th 7th 8th Passes through 13 Gate, 9th 10th 11th 12th Passes through 8¼ Gate, 13th Pass through 6" Gate, making approximately 6½ Square Bloom.
(3044.A) "ENGINEERING"

Fig. 3.
UNIVERSAL MANIPULATOR FOR COGGING MILL.

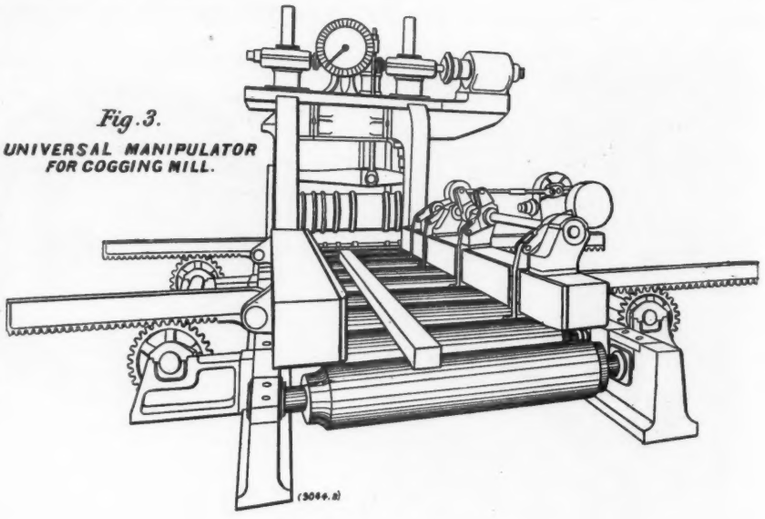
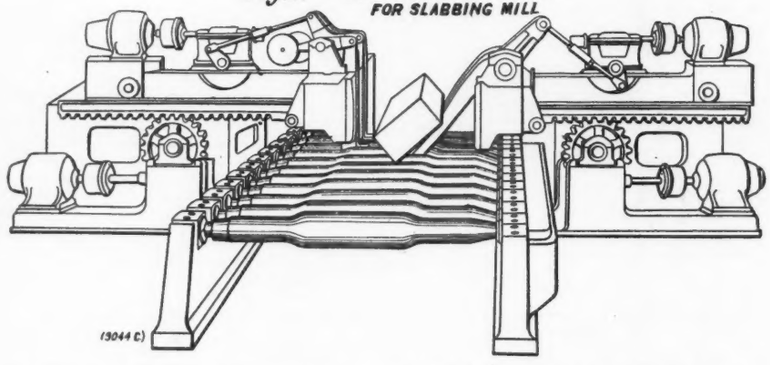


Fig. 4. UNIVERSAL MANIPULATOR FOR SLABBING MILL



positions on a chart carried on a clockwork-driven drum. The instruments are calibrated before leaving the works and the scales are marked in terms of the actual quantities of steam passing.

It will be obvious that the graph drawn to show the variations in the flow may be used to determine the total quantity of steam that has passed in a given interval of time, by the determination of the area enclosed between the curve and the zero line by means of a planimeter. This work, however, may be avoided by fitting an integrating meter, which gives the total quantity passed from the time of setting. The form of the integrating gear is shown in Fig. 3, while its position in relation to the recording drum and the details of the mechanism may be seen in Figs. 4 to 6, a general view of the complete meter being shown in Fig. 7. In this case the recording drum is mounted with its axis vertical and has the clockwork above it. The integrating mechanism consists of a train of wheels working index fingers over graduated dials. These receive their motion from a small friction wheel, which presses against a revolving horizontal disc, driven by the clockwork at a uniform speed. The motion given to the integrating mechanism will depend upon the distance from the centre of the rotating disc of the point of contact of the friction wheel, and as this is varied by motion from the lever system connected to the floating plate in the cone, the dials may be calibrated to give the actual value of the quantity of steam passed. The manner by which the drive is taken from the shaft connected to the lever mechanism is clearly indicated in Figs. 4 to 6. It will be appreciated that the carriage of the integrating mechanism is effectively supported by a cross shaft passing through a bush and also by an underlying projection at right angles to the shaft.

Troublesome conditions are obtained when the pressure of the steam supply varies, since the volume of steam passing depends upon the pressure. To correct for these variations, The Steam Fittings Company, Limited, have introduced the device shown in Figs. 8 and 9. Here a portion of the recording lever of the instrument has been cut away to a curved shape and interfering motion is communicated to it from a small lever, the position of which is varied as the pressure is changed by its connection to an ordinary Bourdon gauge tube subjected internally to the steam pressure. By arranging a suitable form for the curve left by cutting away part of the recording lever, the interfering motion may be made completely to allow for any variations in steam pressure.

It should be mentioned that not only are these float-type meters suited for use with steam, but they are also available for measurements with other elastic fluids, such as air or gas, or incompressible ones, such as water. Usually, the float system is made of gun-metal, but where superheated steam has to be dealt with Monel metal float discs are fitted. Rustless steel serves for the construction of the float stem and the actuating spindle of the recorder and the integrator, while the small friction disc is made of aluminium.

THE INSTITUTION OF STRUCTURAL ENGINEERS.—It is announced by the Institution of Structural Engineers, of Abbey House, Westminster, London, S.W.1, that Sir Charles T. Ruthen, O.B.E., F.R.I.B.A., has been elected President of the Institution for the year 1925–26 while for the same period Dr. Oscar Faber, O.B.E. M.Inst.C.E., and Messrs. H. J. Deane, M.Inst.C.E. J. Mitchell Moncrieff, C.B.E., M.Inst.C.E., and R. H. H. Stanger, F.C.S., A.M.Inst.C.E., have been elected vice-presidents.

PROGRESS IN BRITISH ROLLING-MILL PRACTICE.*

By T. W. HAND, M.I.Mech.E.

SOME 24 years ago Mr. William Garrett, in reading a paper before this Institute, endeavoured to show, from an American viewpoint, where and to what extent British rolling-mill practice fell short of requirements essential to industrial success.

Admittedly ideal conditions can scarcely be realised in certain steelworks of this country where plant installed by early pioneers has been limited in development through side conditions or financial disability, and remodelling has consequently been permanently handicapped.

The reasoning now generally accepted in America is that the investment cost per unit of annual production is approximately equal for all classes of mill machinery. It follows that the largest producing plant is the better investment, as the necessary replacement of arduous manual effort by mechanical devices results in indisputably lower operating cost.

Billet and Sheet Bar Mills.—Fig. 2 illustrates a typical American roll as used on a so-called 36-in. blooming mill. Very shallow grooves are used, and the rolls always worked open, except on the smallest bloom rolled. This practice results in a roll barrel diameter somewhat disproportionate to the dimensions of its driving elements as compared with the old-style roll with box holes. For this reason American blooming mill size is defined by pinion centres. The rolls indicated are at present dealing with about 60,000 tons per month, the product being 6½-in. square blooms for feeding a Morgan continuous sheet bar mill and a range of slabs for wide strip mills. It will be noted that the ingot is "broken down" on the plain barrelled portion of the roll, thereby eliminating large box holes and incidentally protecting the neck bearings by confining the dispersal of scale to a point nearer the centre of roll. Further, such practice allows of reducing the roll length to the absolute minimum, this in turn permitting of the relatively small diameter already referred to, and giving quicker reduction of the steel with less power consumption.

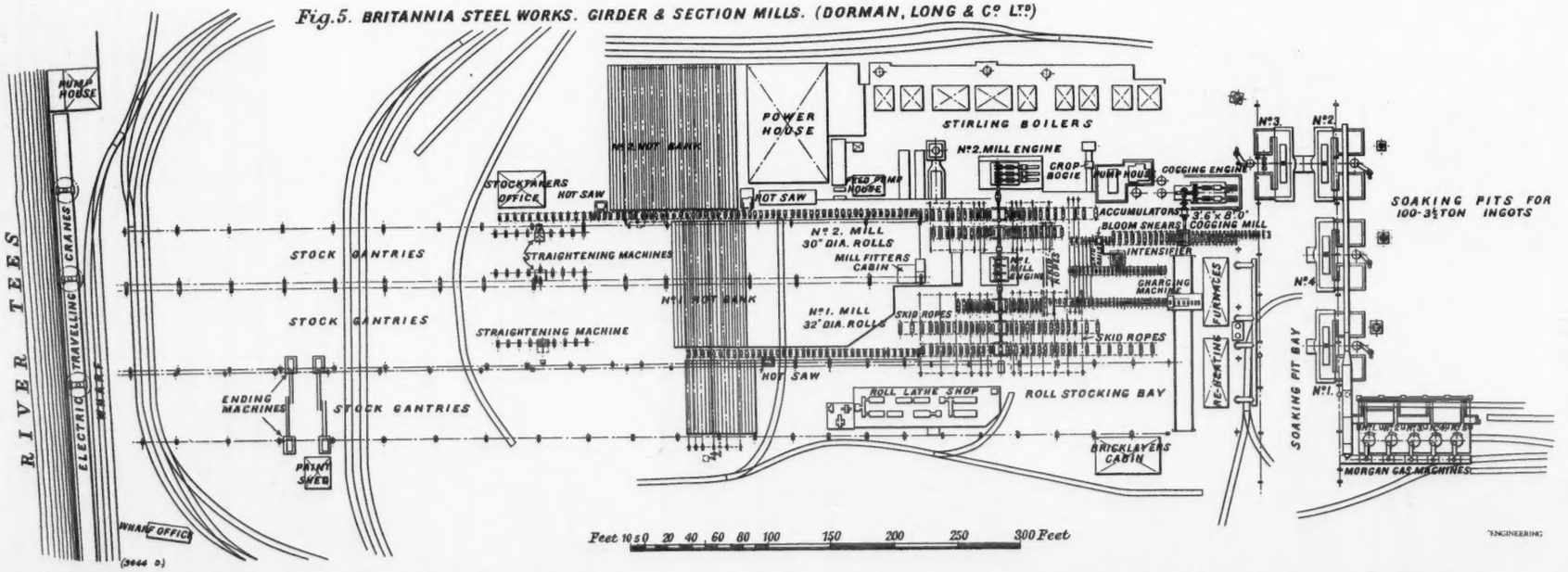
Large tonnages are only made possible by the use of suitable manipulators, and the author has no hesitation in stating that the only type of manipulator to be considered seriously for such duty is the universal or side-guard type, with self-contained tilting elements. This manipulator appears to have been first used on the blooming mill installed at the Grand Crossing Tack Company's plant (now Interstate Iron and Steel Company), near Chicago, in the year 1902. In spite of rapid development, however, in America, Germany and other continental countries, it was not until 1916 that the type was successfully introduced into this country on the 40-in. cogging mill then constructed for Messrs. Bolckow, Vaughan and Co.'s new steel plant at South Bank.

Fig. 3 illustrates this type of manipulator as seen from the front side of a modern cogging mill. It should be noted that a similar pair of side-guards are located at the back side of the rolls, the guards being connected in pairs by through shafts with rack-and-pinion drive, thereby ensuring that when the piece has been guided into the roll pass by the side-guards at the entering side of the mill, the corresponding pair of guards at the delivery side are in line to receive it. Early manipulators of this type were invariably hydraulically operated, but more recently electric drive has been successfully developed, with such advantage as regards ease of operation that on recent certain electrically operated reversing mills in America all movements of the mill are handled by two men in the control pulpit. This has been effected by a combination of hand- and foot-controlled master switches, arranged in such manner that the man who operates the mill tables also takes care of the screwing gear, whilst the second operator handles the manipulator side-guards and tilting fingers, and at the same time controls the main mill motor with two foot switches, one of which he presses with the right foot and the other with his left, the switches

* Paper read before the Iron and Steel Institute, London, on May 7, 1925. Abridged.

BRITISH ROLLING MILL PRACTICE.

Fig.5. **BRITANNIA STEEL WORKS. GIRDER & SECTION MILLS. (DORMAN, LONG & Co LTD)**



being so interlocked that simultaneous operation is impossible.

It is claimed that this subdivision of the work between two operators only, minimises delays and damage through misunderstanding, since No. 1 operator will not travel the piece into the mill before the screwing gear is correctly adjusted, and No. 2 operator is scarcely likely to start up the mill until the piece is correctly lined up with the pass by the side-guards which he himself controls.

Fig. 4 shows the modifications required to make this manipulator suitable for serving a slab mill. It will be observed that the side-guards are deepened for better support of the slab when edged, and cant levers provided in addition to the tilting-hooks to assist in turning up and lowering the slab. All parts of these manipulators are made amply strong and with operating mechanism of sufficient power to straighten a bent piece, a particularly useful feature in closing up any fish-tail ends which may occur.

In a well-developed plant it should never be necessary to change cogging rolls except for periodical dressing or in the event of accident, the roll profile being such that a full range of slabs or blooms required for subsequent operations may be produced.

Large Finishing Mills.—Fig. 5 shows an arrangement of finishing mills used in conjunction with such a cogging mill, and may be taken as representing best practice in this country. It will be observed that two finishing trains are installed, either of which may be worked whilst changing rolls in the other mill. Roll-changing is a vital consideration in this class of mill, the wide range of product covered necessitating a stock of probably 250 pairs of rolls. Such conditions, obviously, call for careful organisation if economical production is to be maintained.

The two finishing trains illustrated differ somewhat in capacity, their respective range of product being approximately as follows :—*Three-stand Mill.*—Joists from 8 in. by 5 in. to 24 in. by 7½ in., and all channels and flats within these limits. *Two-stand Mill.*—Joists 5 in. to 8 in. deep, channels 5 in. to 9 in. deep., bulb angles 5½ in. to 12 in., and angles (equal and unequal) from 3½ in. to 9 in.

The average output of finished product usually realised from such a combination of mills may be taken as about 3,500 tons per week of 16 eight-hour shifts. It should be mentioned, however, that on favourable orders with minimum roll changing larger tonnage could be readily obtained. A noticeable feature of this plant is found in the spacious finishing and stocking bays, also the convenient and economical facilities for despatch of product by either rail or sea.

During more recent years, with higher cost of construction, the tendency has been to install single finishing trains only, what would otherwise appear to be retrograde practice being to some extent compensated by improved design and mechanical construction. A good example of this class of mill may be cited in the 36-in. rail and section mill at Messrs. Baldwin's, Limited, Margam Works, which is now being taken a step nearer completion by the addition of a reversing motor drive at the end of the train remote from the steam-engine formerly constituting the only driving unit.

Whilst no revolutionary changes have occurred in structural and rail-mill practice in this or other countries during the period under review, many improvements have been effected in mechanical details of plant which have greatly stimulated output and enormously reduced manual effort. In view of the difficulty in handling long pieces, rolls have been designed to eliminate turning over the piece as far as ever possible, particularly as regards the finishing rolls.

In our latest reversing mills, plain guide pushers are provided at these rolls, and manipulators at the first and second roughing stands. Several successful types of the latter have been developed since the original of Evans and Lewis, these being illustrated in Figs. 6, 7 and 8, whilst Fig. 9 shows a type found useful for the 180-deg. forward-and-backward turns given to tram rails, &c., at the finishing rolls.

Much attention has been given to roll-changing facilities, housings and fittings being on the latest mills so arranged that a pair of rolls can be completely changed with very little disturbance of chocks and driving spindles, the whole operation taking about 30 minutes only.

Fig. 10 illustrates such a housing design, the arrangement also incorporating a hydraulically operated spindle positioning and coupling-box sliding gear, which has proved particularly useful in manipulating these parts during roll-changing operations.

Whilst considering features of construction, reference might be made to another device which, where applicable, results in considerable economy in the use of neck-bearing material. Fig. 11 illustrates this device as used on a cogging mill.

As usually arranged, the housing chocks are provided with endwise "setting-up" facilities, so as to allow of the grooves in the two rolls being readily adjusted in correct relationship. With every care and allowance for lengthwise expansion of the rolls when hot, considerable end pressure is found to be exerted on the inside faces of the bearing steps, resulting in these being frequently worn away long before the steps have otherwise reached the renewal stage. In the improved arrangement illustrated, the roll is retained in position at one end only by means of an adjustable outside cap, which in conjunction with the inside face of the roll barrel constitutes in effect a double-collared journal bearing, and allows the other end of the roll to be left well clear and free to expand. Incidental advantages are derived from simplified adjustment of the roll through dealing with one end only, and considerably reduced screwing power owing to minimised friction on roll chock-slides.

Since the introduction of heavier ingots, reheating the cogged bloom has become standard practice at most rail and section mills, considerable advantage being obtained as regards control of finishing temperature and appearance of finished product in certain qualities of steel. Such reheating can usually be effected with fuel expenditure of about 112 lb. of producer coal per ton of product, or more economically still if blast furnace or coke oven gas is available.

Plate Mills.—The relative advantages of three-high continuously running and two-high reversing mills have been much debated, opinion being still divided, and practice in the United Kingdom agreeing fairly closely with that obtaining generally throughout Europe. It is somewhat significant, however, that several of the plate manufacturers who have been longest in the business are now favouring the three-high mill.

In America the reversing plate mill, except when used as a "rougher" in tandem with a three high finishing

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Fig. 6. "WILLIAMS" MANIPULATOR.

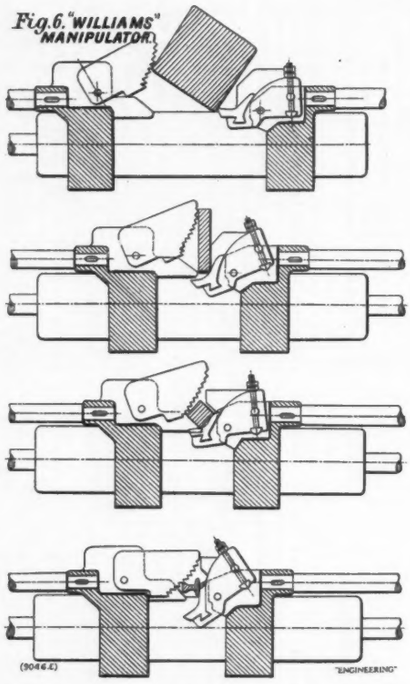


Fig. 7. "DAVIES" MANIPULATOR.

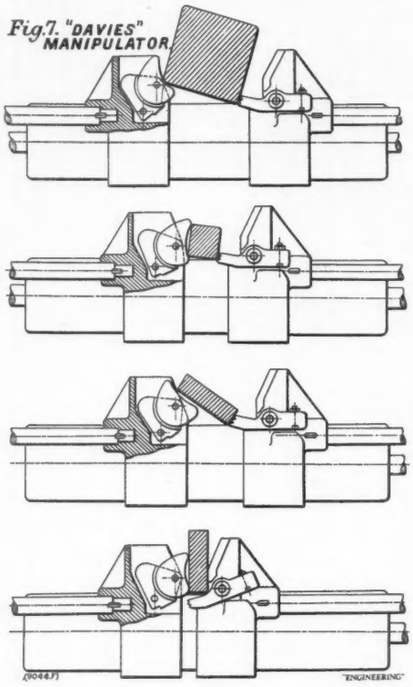
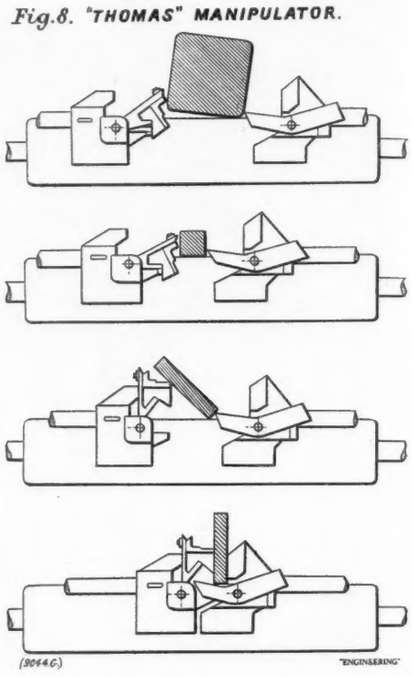


Fig. 8. "THOMAS" MANIPULATOR.



mill, or for rolling universal plate, is practically unknown, the three-high type being very highly developed. Based on actual observation, the author is of opinion that such mills will give an equally good product as regards finish, and it is a moot point whether by taking advantage of the possibility of slightly barrelling the small middle roll to suit the contour of the top and bottom roll when worn, plates of more even thickness may not be rolled.

The latter consideration is of vital importance in all plate mills, as any excess in thickness of the plate at its centre beyond the usual tolerance of, say, 5 per cent., results in the purchaser being presented with steel for which the manufacturer, of course, receives no payment. In admittedly good practice this may amount to a by no means negligible weight of steel per week. Such contingency has been to some extent guarded against in certain of the more recent mills installed in Great Britain by using rolls of considerably increased diameter for a given length of barrel, thereby minimising "spring" to the greatest possible extent.

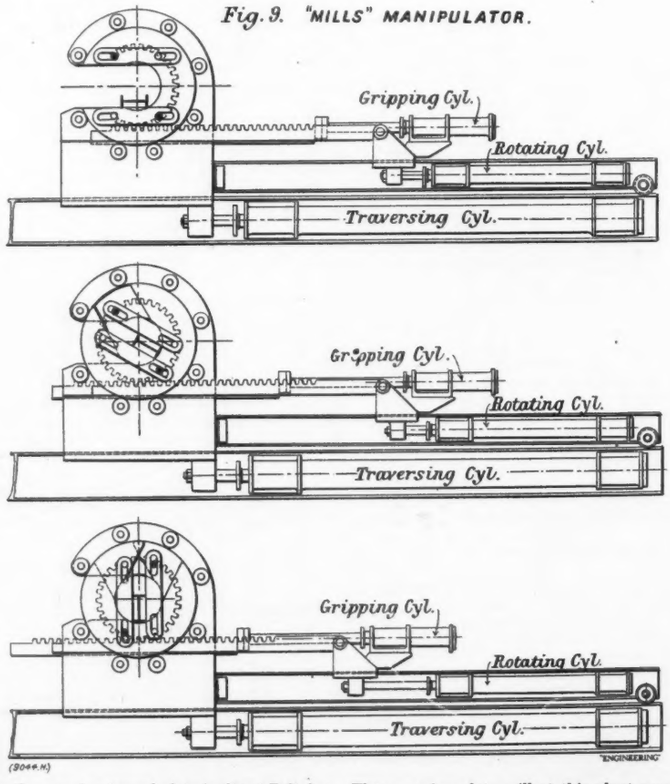
Whilst there are still many obsolete British plate mills, it can with perfect justification be claimed that the new plants laid down in recent years embody all the best features of modern practice. Manual effort has, in fact, been perhaps more completely eliminated in certain of these mills than in any similar foreign plant. This claim applies in particular to the shearing of plates, formerly a most arduous operation, but now entirely mechanical for all other than irregularly shaped or sketch plates. Very naturally, in an individualistic country, differences of opinion exist, and various methods of shearing are in use, each of which has proved advantageous for particular conditions, and to which reference is made later.

Fig. 14 illustrates a well-arranged plate mill plant laid down a few years ago on the north-east coast. Ingots of 5, 7, or 10 tons are normally worked, the plant having been laid out, however, to deal with 16-ton ingots when required.

This installation comprises a 42-in. by 10-ft. slabbing mill, a 42-in. by 9-ft. 6-in. two-stand reversing plate mill, and a universal mill capable of rolling universal plate from 15 in. to 42 in. wide, and up to 90 ft. in length. Sheared plate up to 6 ft. wide may also be produced in the usual manner by removing the vertical rolls from the mill. This combination of mills has proved easily capable of a production of over 4,000 tons of sheared plate per week, about 75 per cent. of this being rolled on the large reversing mill.

In a modern sense the universal mill illustrated is the first of its type to be set to work in Great Britain, but having regard to the organisation to which it belongs, and the fact that another mill of somewhat greater capacity is being installed by well-known tube makers in Scotland, it would appear that former objections to the use of universal plate in Great Britain were largely based on prejudice. The most valid of these objections, the difficulty of obtaining long plates with the two sides sufficiently parallel and straight as entirely to dispense with shearing or planing, have long been overcome by the development of effective side-straightening apparatus, which handles the plate immediately after leaving the mangle rolls, and before reaching the cooling bank. The product of the universal mill illustrated is sold to a tolerance of $\frac{1}{16}$ in. side curvature only on a length of 5 ft.

Fig. 9. "MILLS" MANIPULATOR.



The reversing plate mill at this plant comprises two stands of rolls of identical size, 42 in. diameter by 9 ft. 6 in. long, these proportions being similar to those of a somewhat earlier mill in the same district, and another quite recently installed still farther north.

Reverting to Fig. 14, it will be seen that "Ennis" shearing tables are in use, a more detailed view of these being shown by Fig. 15. These tables really constitute an extension of the roller table beyond the end-cut shears, the plate after having its ends squared being run through the shears and carried by the

BRITISH ROLLING MILL PRACTICE.

Fig. 10a. ROLL CHANGING DEVICES.

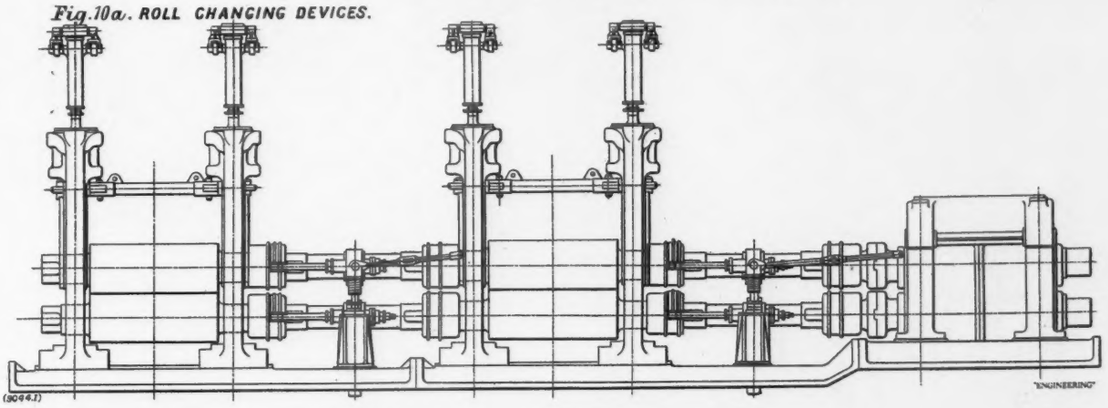


Fig. 10 b. REMOVAL OF BOTTOM ROLL.

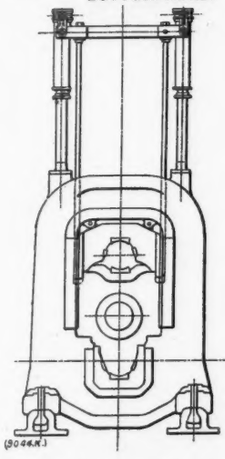


Fig. 10c. REMOVAL OF TOP ROLL.

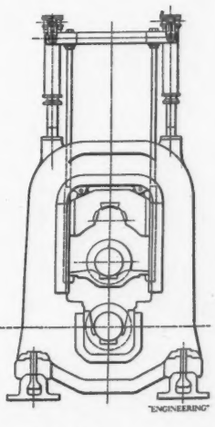


Fig. 10 d.

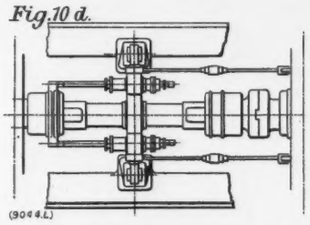


Fig. 10 e.

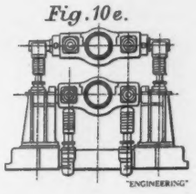
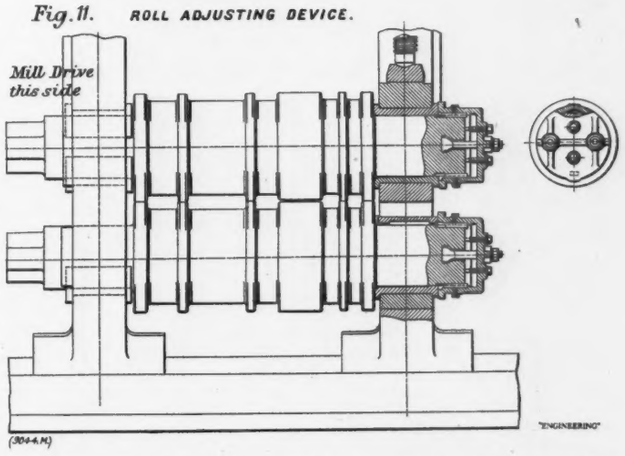


Fig. 11. ROLL ADJUSTING DEVICE.



"Ennis" table direct to side-cut shears. The table illustrated is provided with two sets of feed rollers, each set being separately driven, so that opposite direction of rotation will turn the plate completely round for trimming of both edges. Interposed between the rollers are transverse skids fitted with magnetic tops, which serve the double purpose of placing the plate in position and clamping down whilst being sheared.

By way of comparison, it might be mentioned that the shear referred to is operated by two men only, one of these controlling all movements of the shear and "Ennis" table, the other being occupied in the removal of scrap. This particular equipment has sheared 131 tons of plate in an eight-hour shift, as compared with 181 tons at the castor-bed shear at the other end of the cooling bank, and on which a gang of eight men are employed. The cooling banks at this plant are of novel construction, the plates being supported on rows of disc rollers and transferred over these by "Ennis" magnetic skids. It is claimed for these devices that any plate in the bank may be moved in either direction with the minimum of mechanism, it being only necessary to run the skid under the plate and grip this by energising the skid magnet.

(To be continued.)

NOTES ON NEW BOOKS.

FOR the design of engineering structure it is essential that adequate information on the properties of the materials to be used should be available. The need for this is now usually met by classes in technical colleges and universities, where it is possible to verify the determinations by personally conducted tests in the laboratories. Prof. G. F. Swain, LL.D., of Harvard University, has recently written a book on this side of a civil engineer's studies, with the title "*Structural Engineering—Fundamental Properties of Materials*," in which he has attempted to avoid going into great detail, but rather to bring together the consideration of the fundamental properties of the materials, their constitution and physical structure, the effects of added ingredients and treatment, as well as the significance of the specifications used to secure the desired characteristics in the materials to be employed. This book is really the second volume of a series of four, in which the author intends to cover the whole wide field of structural engineering. It is published by the McGraw-Hill Publishing Co. Limited, of 6 and 8, Bouverie-street, London, E.C.4, at 12*s.* 6*d.* net. In contrast with this phase of civil engineering study, the same firm have also published a work entitled "*Detailing and Fabricating Structural Steel*," by Mr. F. W. Dencer, of the American Bridge Company. This book, which is sold at 25*s.* net, is a thoroughly practical manual for the use of those engaged in actual design. Within its scope are embraced the discussion of workshop organisation, the study of designs and specifications, the handling of contracts, the fabrication, inspection and the shipping of structures. A great variety of constructional work is referred to in the volume, and the information provided is of the type that a young engineer requires for his work. The practice dealt with is, of course, American, but only in some sections does this detract from the value and importance of its contents to British engineers.

The cost of fuel in modern industry is of such great significance in the total costs of production that exact information on the subject should be readily available. Usually the facts are scattered among official papers and are sometimes difficult to obtain. For coal the statistical information is now available in a handy form in "*The Colliery Year Book and Coal Trade Directory*, 1925," in which the data are arranged so that it is an easy matter to trace the variations in the cost of coal production from year to year and also the magnitude of each of the component costs. The amount of the exports each year and the home consumption are given in tabular form, as well as information relating to such matters as employment, wages and disputes, and accidents, diseases and mortality among miners. Articles on the methods of analysis of coal, the preparation of coal for the market and on the composition of typical British coals are included in this useful reference book. There is also a complete review of the coal-mining industry in 1924 and information is provided on the National Wages Agreement. Mines Regulations are also incorporated in the volume. The directory part of the Year Book gives an alphabetical list of the collieries, with the names of the directors and chief officials, while there is a section devoted to "Who's Who in the Coal Mining Industry." On looking casually through the Directory some printer's errors are seen that might well have been picked up before publication. This Year Book is published by the Louis Cassier Company, Limited, 34, Bedford-street, Strand, London, at a price of 21*s.* net.

For the prosecution of endeavours to get into business associations with the manufacturers and merchants of the world it is essential that directions are available, which have the characteristic of including numerous entries relating to the people making or dealing in any specific product and an accuracy of detailed particulars relating to them, which ensures that absolute reliance may be placed on the statements relating to the firms. Such a high standard is difficult

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(*For Description, see Page* 778.)

Fig.14. REDCAR STEELWORKS AND ROLLING MILLS. (DORMAN, LONG & Co LTD)

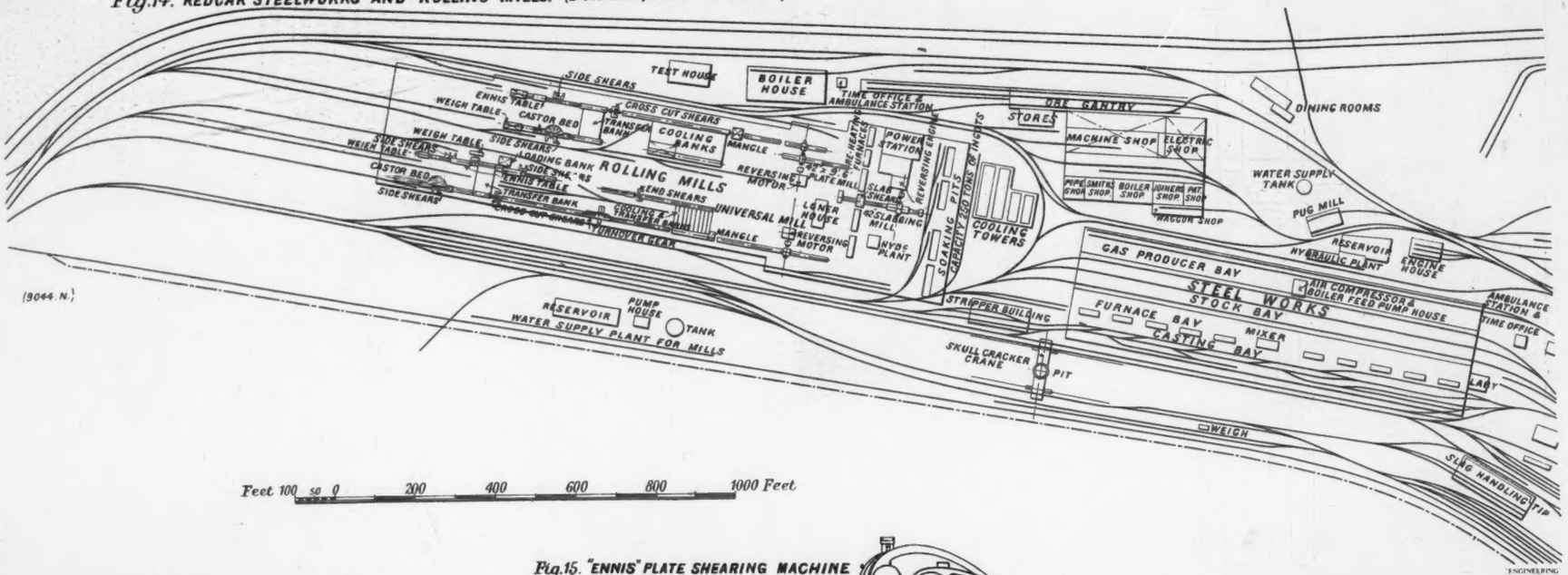
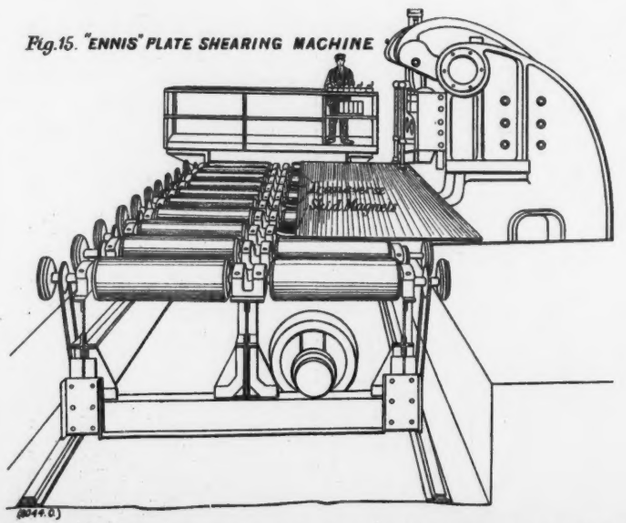


Fig.15. "ENNIS" PLATE SHEARING MACHINE



to attain as anyone who considers the work involved will readily appreciate. That it is not impossible is manifest from such a work as "*Kelly's Directory of Merchants, Manufacturers and Shippers of the World*," which has now reached its thirty-ninth edition. This new edition consists of two volumes, one of which deals with the British Empire and the other, of the same size, gives reference to the industrial and trading communities of other lands. When it is remembered that the two volumes have an aggregate of 5,000 pages and give over 1,500,000 entries under the various trade descriptions, it will be seen that the work must be one of the most valuable that a merchant can possess. Many corrections are made each year in the entries, to maintain the standard of accuracy that has been set up, while the indexes are given in five languages and the instructions regarding the arrangement of the book greatly facilitate its use. We can strongly recommend this valuable work, which is published at a price of 64*s.*, post free, by Kelly's Directories, Limited, 186, Strand, London, W.C.2.

"*The Sweden Year Book*, 1925," a well-printed little volume in the English language, is edited in Sweden, published at Stockholm by Messrs. Almqvist and Wiksells Boktryckeri-A.B., and issued by the Swedish Consul-General in London, Bank Chambers, 329, High Holborn, W.C.1. It contains short articles on the various aspects of contemporary Swedish life, as well as the customary information on economic, financial and administrative matters. Chapters dealing with the iron, timber and wood-pulp industries are of special interest. One of the most important of the natural resources of Sweden is its supply of water power and although, according to the Year Book, only a fraction of this force is at present used, this fraction nevertheless represents some 1,250,000 h.p. The increased utilisation of its water power will no doubt greatly influence the country's future development. The book contains several maps, together with many illustrations and plates. It is well indexed and is altogether a handy work of reference.

TESTS OF CHROME STEEL MAGNETS.—The chrome steel which P. Oberhoffer and O. Emicke tested (Stahl und Eisen, April 9) contained 1 per cent. of carbon, 1·6 of chromium, 0·25 of manganese, and 0·15 of silicon. Two blocks were used, one of 220 kg., the other of 100 kg. weight, and were partly rolled into rods and drawn to wire. The steel of both the blocks showed segregation, which was almost completely removed, particularly in the larger block, by reheating to 1,150 or 1,200 deg. C. for 20 hours; this reheating did not affect the strength or the magnetic properties. The rolling was effected at about 1,000 deg. (940 deg. to 1,150 deg. C.); it had a beneficial influence when the preheating had not been too prolonged; otherwise partial decarburation took place. Quenching in oil gave in general more uniform results than quenching in water; short-limb magnets of large pole gap should be quenched in oil, for long-limbed magnets of short gap quenching in water may be preferable. With rising quenching temperature the magnetic properties tended to maximum values, which depended upon the length of the heating period and the rate of quenching, falling off subsequently. The remanence increased and the coercive force decreased as the quenching temperature rose; this was particularly marked between 250 deg. and 350 deg. Up to about 100 deg. the product of remanence and coercive force was almost constant; afterwards it decreased. Mechanical stress (repeated drop tests, hammering) affected these two last-mentioned quantities in irregular ways, raising or lowering the figures.